National Marine Fisheries Service Endangered Species Act (ESA) Section 7(a)(2) Biological Opinion and Magnuson-Stevens Fishery Conservation and Management Act Essential Fish Habitat Response

Consultation on the Issuance of 17 ESA Section 10(a)(1)(A) Scientific Research Permits in Oregon, Washington, and California affecting Salmon, Steelhead, Eulachon, and Green Sturgeon in the West Coast Region

NMFS Consultation Number: WCRO-2020-02340
ARN 151422WCR2020PR00177

Action Agencies: The National Marine Fisheries Service (NMFS)
The United States Fish and Wildlife Service (USFWS)
The United States Geological Survey (USGS)
The United States Forest Service (USFS)
The Bonneville Power Administration (BPA)
The United States Environmental Protection Agency (EPA)
The United States Army Corps of Engineers (Corps)

Affected Species and NMFS' Determinations:

ESA-Listed Species	Status	Is Action Likely To Adversely Affect Species?	Is Action Likely To Jeopardize the Species?	Is Action Likely To Adversely Affect Critical Habitat?	Is Action Likely To Destroy or Adversely Modify Critical Habitat?
Puget Sound (PS) Chinook salmon (*O. tshawytscha*)	Threatened	Yes	No	No	No
PS steelhead (*O. mykiss*)	Threatened	Yes	No	No	No
Upper Columbia River (UCR) steelhead (*O. mykiss*)	Threatened	Yes	No	No	No
Deschutes River Non-essential Experimental Population (NEP) of MCR steelhead (*O. mykiss*)	NEP until 2025	Yes	No	No	No
Lower Columbia River (LCR) Chinook salmon (*O. tshawytscha*)	Threatened	Yes	No	No	No
LCR coho salmon (*O. kisutch*)	Threatened	Yes	No	No	No

ESA-Listed Species	Status	Is Action Likely To Adversely Affect Species?	Is Action Likely To Jeopardize the Species?	Is Action Likely To Adversely Affect Critical Habitat?	Is Action Likely To Destroy or Adversely Modify Critical Habitat?
LCR steelhead (*O. mykiss*)	Threatened	Yes	No	No	No
Columbia River (CR) chum salmon (*O. keta*)	Threatened	Yes	No	No	No
Upper Willamette River (UWR) Chinook salmon (*O. tshawytscha*)	Threatened	Yes	No	No	No
UWR steelhead (*O. mykiss*)	Threatened	Yes	No	No	No
Southern Oregon/Northern California Coast (SONCC) coho salmon (*O. kisutch*)	Threatened	Yes	No	No	No
Northern California (NC) steelhead (*O. mykiss*)	Threatened	Yes	No	No	No
California Coastal (CC) Chinook salmon (*Oncorhynchus tshawytscha*)	Threatened	Yes	No	No	No
Sacramento River (SacR) winter-run Chinook salmon (*O. tshawytscha*)	Endangered	Yes	No	No	No
Central Valley spring-run (CVS) Chinook salmon (*O. tshawytscha*)	Threatened	Yes	No	No	No
California Central Valley (CCV) steelhead (*O. mykiss*)	Threatened	Yes	No	No	No
Central California Coast (CCC) coho salmon (*O. kisutch*)	Endangered	Yes	No	No	No
Central California Coast (CCC) steelhead (*O. mykiss*)	Threatened	Yes	No	No	No
South-Central California Coast (SCCC) Steelhead (*O. mykiss*)	Threatened	Yes	No	No	No
Southern California (SC) steelhead (*O. mykiss*)	Endangered	Yes	No	No	No
Southern Distinct Population Segment (sDPS) eulachon (*Thaleichthys pacificus*)	Threatened	Yes	No	No	No
sDPS green sturgeon (*Acipenser medirostris*)	Threatened	Yes	No	No	No

ESA-Listed Species	Status	Is Action Likely To Adversely Affect Species?	Is Action Likely To Jeopardize the Species?	Is Action Likely To Adversely Affect Critical Habitat?	Is Action Likely To Destroy or Adversely Modify Critical Habitat?
Southern Resident killer whale (SRKW) (*Orcinus orca*)	Endangered	No	No	No	No

Fishery Management Plan That Describes EFH in the Project Area	Does Action Have an Adverse Effect on EFH?	Are EFH Conservation Recommendations Provided?
Pacific Coast Salmon	No	No

Consultation Conducted By: National Marine Fisheries Service, West Coast Region

Issued By: Chris E Yates
For
Regional Administrator

Date: September 25, 2020

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List of Acronyms

AMIP – Adaptive Management and Implementation Plan
ARN – Administrative Record Number
BPA – Bonneville Power Administration
C/H/R – Capture/Handle/Release
C/M, T, S/R – Capture/Mark, Tag, Sample Tissue/Release Live Animal
CC – California Coastal
CCC – Central California Coast
CCT - The Confederated Tribes of the Colville Reservation (Colville Confederated Tribes)
CDFW – California Department of Fish and Wildlife
CFR – Code of Federal Regulation
CH – Critical Habitat
CHART – Critical Habitat Analytical Review Teams
CR – Columbia River
CVS – Central Valley spring-run
CWT – Coded Wire Tag
DC – Direct Current
DEQ – Oregon Department of Environmental Quality
DFO – Department of Fisheries and Oceans
DIDSON – Dual Frequency Identification Sonar
DPS – Distinct Population Segment
DQA – Data Quality Act
EFH – Essential Fish Habitat
EPA – Environmental Protection Agency
ESA – Endangered Species Act
ESU – Evolutionarily Significant Unit
FR – Federal Register
HRC – Humboldt Redwood Company
HUC5 – Hydrologic Unit Code (fifth-field)
IDFW – Idaho Department of Fish and Wildlife
IM – Intentional (Directed) Mortality
IPCC – Intergovernmental Panel on Climate Change
ITS – Incidental Take Statement
LCR – Lower Columbia River
LHAC – Listed Hatchery Adipose Clipped
LHIA – Listed Hatchery Intact Adipose
MCR – Middle Columbia River
MPG – Major Population Group
MSA – Magnuson-Stevens Fishery Conservation and Management Act
NC – Northern California
NEP – Non-essential Experimental Population
NFH – National Fish Hatchery
NMFS – National Marine Fisheries Service
NOAA – National Oceanic and Atmospheric Administration
NWFSC – Northwest Fisheries Science Center

O/H – Observe/Harass
OC – Oregon Coast
ODFW – Oregon Department of Fish and Wildlife
PBF – Physical or Biological Features
PCE – Primary Constituent Element
PFMC – Pacific Fishery Management Council
PIT – Passive Integrated Transponder
PRD – Protected Resources Division
PS – Puget Sound
RCD – Resource Conservation District
RPM – Reasonable and Prudent Measure
RM – River Mile
S – Southern
SacR – Sacramento River
sDPS – Southern Distinct Population Segment
SINDNR – Samish Indian Nation Department of Natural Resources
SONCC – Southern Oregon/Northern California Coast
spr/sum – spring/summer run
SRKW – Southern Resident killer whale
SRSC – Skagit River System Cooperative
TRT – Technical Recovery Team
UCR – Upper Columbia River
USDA – United Stated Department of Agriculture
USFS – United States Department of Agriculture Forest Service
USFWS – United States Fish and Wildlife Service
USGS –United States Geological Survey
UWR – Upper Willamette River
VSP – Viable Salmonid Population
WCR – West Coast Region
WDFW – Washington Department of Fish and Wildlife
WR – Winter Run

1. INTRODUCTION

This Introduction section provides information relevant to the other sections of this document and is incorporated by reference into Sections 2 and 3 below.

1.1 Background

The National Marine Fisheries Service (NMFS) prepared the biological opinion (opinion) and incidental take statement (ITS) portions of this document in accordance with section 7(b) of the Endangered Species Act (ESA) of 1973 (16 USC 1531 et seq.), and implementing regulations at 50 CFR 402, as amended. It constitutes a review of 17 scientific research permits NMFS is proposing to issue under section 10(a)(1)(A) of the ESA and is based on information provided in the associated applications for the proposed permits, published and unpublished scientific information on the biology and ecology of listed salmonids in the action areas, and other sources of information.

We also completed an essential fish habitat (EFH) consultation on the proposed action, in accordance with section 305(b)(2) of the Magnuson-Stevens Fishery Conservation and Management Act (MSA) (16 U.S.C. 1801 et seq.) and implementing regulations at 50 CFR 600.

We completed pre-dissemination review of this document using standards for utility, integrity, and objectivity in compliance with applicable guidelines issued under the Data Quality Act (DQA) (section 515 of the Treasury and General Government Appropriations Act for Fiscal Year 2001, Public Law 106-554). The document will be available within two weeks at the NOAA Library Institutional Repository [https://repository.library.noaa.gov/welcome]. A complete record of this consultation is on file at the Protected Resources Division in Portland, OR.

1.2 Consultation History

The West Coast Region's (WCR's) Protected Resources Division (PRD) received 20 applications for permits to conduct scientific research in Washington, Oregon and California:

- 17 applications were to renew existing permits;
- One application was to modify an existing permit; and
- Two applications were for new permits.

Three of these applications were withdrawn before or during the public comment period (all were applications to renew ongoing research). The remaining 17 application numbers and their respective responsible parties are displayed below in Table 1 and described in the text following it. Because the permit requests are similar in nature and duration and are expected to affect many of the same listed species, we combined them into a single consultation pursuant to 50 CFR 402.14(c).

The affected species are:

- Chinook salmon
    - Puget Sound (PS)
    - Lower Columbia River (LCR)

    - Upper Willamette River (UWR)
    - California Coastal (CC)
    - Sacramento River winter-run (SacR WR)
    - Central Valley spring-run (CVS)
- Coho salmon
    - Lower Columbia River (LCR)
    - Southern Oregon/Northern California Coast (SONCC)
    - Central California Coast (CCC)
- Chum salmon
    - Columbia River (CR)
- Steelhead
    - Puget Sound (PS)
    - Upper Columbia River (UCR)
    - Deschutes River Non-essential Experimental Population (NEP) of Middle Columbia River (MCR)
    - Lower Columbia River (LCR)
    - Upper Willamette River (UWR)
    - Northern California (NC)
    - California Central Valley (CCV)
    - Central California Coast (CCC)
    - South-Central California Coast (SCCC)
    - Southern California (SC)
- Southern DPS (sDPS) Eulachon
- Southern DPS (sDPS) Green sturgeon

The proposed actions also have the potential to affect Southern Resident killer whales (SRKW) and their critical habitat by diminishing the whales' prey base. We concluded that the proposed activities are not likely to adversely affect SRKW or their critical habitat and the full analysis for that conclusion is found in the "Not Likely to Adversely Affect" Determination section (2.11).

Table 1. The Applications Considered in this Biological Opinion—and Their Associated Applicants.

Permit Number	Applicant
1336-9R	Port Blakely Tree Farms, L.P.
13791-7R	U.S. Fish and Wildlife Service – Lodi Office
14516-3R	San Jose State University
14808-5R	California Department of Fish and Wildlife – Sacramento Office
15215-2R	California Department of Fish and Wildlife – Fish Health Laboratory
15390-2R	Resource Conservation District of the Santa Monica Mountains
16122-3R	Confederated Tribes of the Colville Reservation
16290-4R	Oregon Department of Fish and Wildlife
16417-3M	Santa Clara Valley Water District

Permit Number	Applicant
17063-3R	U.S. Forest Service
17272-2R	U.S. Fish and Wildlife Service – Arcata Office
17867-2R	Humboldt Redwood Company, LLC.
18921-2R	Samish Indian Nation
18937-3R	Scripps Institution of Oceanography
19121-2R	U.S. Geological Survey
23649	Mount Hood Environmental
23843	Skagit River System Cooperative

Most of the requests were deemed incomplete to varying extents when they arrived. After numerous phone calls and e-mail exchanges, the applicants revised and finalized their applications.

Permit 1336-9R – On March 23, 2020, Port Blakely Tree farms contacted us about renewing their permit. After a number of requested changes were made to the application while it was in draft form, we received a final permit renewal request on April 16, 2020. The application was then reviewed and deemed complete on June 30, 2020.

Permit 13791-7R – We received a permit renewal request from the U.S. Fish and Wildlife Service (USFWS) Lodi Office on March 31, 2020. Requested edits were sent, addressed, and the application was deemed complete on July 28, 2020.

Permit 14516-3R – We received a permit renewal request from San Jose State University on April 11, 2020. Requested edits were sent, addressed, and the application was deemed complete on July 27, 2020.

Permit 14808-5R – We received a permit renewal request from the California Department of Fish and Wildlife (CDFW) Sacramento Office on March 30, 2020. Requested edits were sent, addressed, and the application was deemed complete on July 6, 2020.

Permit 15215-2R – We received a permit renewal request from the California Department of Fish and Wildlife (CDFW) Fish Health Laboratory on April 2, 2020. Requested edits were sent, addressed, and the application was deemed complete on June 26, 2020.

Permit 15390-2R – We received a permit renewal request from the Resource Conservation District (RCD) of the Santa Monica Mountains on April 21, 2020. Requested edits were sent, addressed, and the application was deemed complete on June 26, 2020.

Permit 16122-3R – We received a permit renewal request from The Confederated Tribes of the Colville Reservation (Colville Confederated Tribes—CCT) on March 17, 2020. No edits nor changes were considered necessary, so the application was deemed complete on March 17, 2020.

Permit 16290-4R – We received a permit renewal request from the Oregon Department of Fish and Wildlife (ODFW) on March 30, 2020. Requested edits were sent and addressed, personnel changes were made, and the application was deemed complete on June 30, 2020.

Permit 16417-3M – We received a permit modification request from the Santa Clara Valley Water District on May 5, 2020. Requested edits were sent, addressed, and the application was deemed complete on June 30, 2020.

Permit 17063-3R – We received a permit renewal request from the U.S. Forest Service (USFS) on March 9, 2020. Requested edits were sent, addressed, and the application was deemed complete on July 9, 2020.

Permit 17272-2R – We received a permit renewal request from the U.S. Fish and Wildlife Service (USFWS) Arcata Office on March 30, 2020. Requested edits were sent, addressed, and the application was deemed complete on June 17, 2020.

Permit 17867-2R – We received a permit renewal request from Humboldt Redwood Company (HRC) Fisheries Monitoring Project on March 5, 2020. Requested edits were sent, addressed, and the application was deemed complete on June 16, 2020.

Permit 18921-2R – We received a permit renewal request from the Samish Indian Nation Department of Natural Resources (SINDNR) on May 27, 2020. Requested edits were sent on June 3, 2020, addressed by the applicant, and the application was deemed complete on June 5, 2020.

Permit 18937-3R – We received a permit renewal request from the Scripps Institution of Oceanography on April 1, 2020. We reviewed the application and requested additional information from the applicant on June 26, 2020. The applicant provided additional information on June 29, 2020, and we deemed the application complete on June 30, 2020.

Permit 19121-2R – We received a permit renewal request from the U.S. Geological Survey on July 1, 2020. We reviewed the application and requested additional information from the applicant on July 17, 2020. The U.S. Geological Survey (USGS) provided additional information, resubmitted their application, and the application was deemed complete on July 29, 2020.

Permit 23843 – We received a permit request (18921-2R) from the Skagit River System Cooperative (SRSC) on May 26, 2020. Requested edits were sent on June 11, 2020, addressed by the applicant, and the application was completed on June 26, 2020.

Permit 23649 – We received a new permit request from Mount Hood Environmental on December 23, 2019. Requested edits were sent and addressed, and the application was completed on June 30, 2020.

After the applications were reviewed, we published notice in the Federal Register on July 27, 2020 asking for public comment on them (85 FR 45192). The public was given 30 days to comment on the permit applications and, once that period closed on August 26, 2020 the consultation was formally initiated on August 27, 2020. The full consultation histories for the actions are lengthy and not directly relevant to the analysis for the proposed actions and so are not detailed here. A complete record of this consultation is maintained by the Protected Resources Division and kept on file in Portland, Oregon.

1.3 Proposed Federal Action

Under the ESA, “action” means all activities or programs of any kind authorized, funded, or carried out, in whole or in part, by Federal agencies (50 CFR 402.02).

Under the MSA, “Federal action” means any action authorized, funded, or undertaken, or proposed to be authorized, funded, or undertaken by a Federal Agency (50 CFR 600.910).]

The proposed actions here are NMFS’ issuance of 17 scientific research permits pursuant to section 10(a)(1)(A) of the ESA. The permits would cover the research activities proposed by the applicants listed in Table 1, above. The permits would variously authorize researchers to take all the species listed on the front page of this document (except for Southern Resident killer whales). “Take” is defined in section 3 of the ESA; it means to harass, harm, pursue, hunt, shoot, wound, kill, trap, capture or collect [a listed species] or to attempt to engage in any such conduct.

We considered, under the ESA, whether the proposed action would cause any other activities and determined that it would not.

Permit 1336-9R

Port Blakely Tree Farms is seeking to renew for five years a permit that currently allows it to take juvenile UWR Chinook salmon, LCR Chinook salmon, LCR coho salmon, UWR steelhead and LCR steelhead in headwater streams in western Oregon and Washington. The purpose of the research is to evaluate factors limiting fish distribution and water quality in streams on land that Port Blakely Tree Farms owns and manages. The research would benefit listed salmonids by producing data to be used in conserving the species and restoring critical habitat. Port Blakely Tree Farms proposes to capture (using backpack electrofishing and dipnetting), handle, and release juvenile fish. The researchers do not intend to kill any fish being captured but a small number may die as an unintended result of the research activities.

Permit 13791-7R

The Lodi office of the USFWS is seeking to renew for five years a permit that allows them to annually take adult and juvenile SacR WR Chinook salmon, CVS Chinook salmon, CCV steelhead, and sDPS green sturgeon while conducting research at long-term monitoring sites in the Sacramento River, San Joaquin River, San Joaquin Delta, San Pablo Bay, San Francisco Bay, Suisun Bay, and the Cache Slough complex in the California Central Valley as well as the San Joaquin Valley and San Francisco Estuary in California. Fish would be captured (Kodiak trawl, midwater trawl, beach seine, zooplankton net, larval net, gill net, fyke net, purse seine, light trap, and boat electrofishing), handled (weighed, measured, and checked for marks or tags), and released. A subsample of adult and juvenile fish from any of the stated species would be marked, tagged, and/or sampled for biological tissue. Subsamples of hatchery-origin juvenile Sacramento River winter-run and Central Valley spring-run Chinook salmon and larval sDPS green sturgeon will be lethally sampled for coded wire tag collection or larval fish species identification, respectively. The purpose of the research is to collect scientific data to evaluate and monitor: (1) abundance, temporal and spatial distribution, and survival of salmonids and other fishes in the Sacramento and San Joaquin rivers and San Francisco Estuary; (2) occurrence and habitat use of fishes within the Liberty Island and Cache Slough Complex; (3) relative gear efficiency for all Interagency Ecological Program fish survey nets; (4) juvenile Chinook Salmon littoral habitat use in the Delta; (5) abundance and distribution of Delta Smelt; (6) length-at-date race criteria of winter-run sized and larger Chinook Salmon; (7) winter- and spring-run sized Chinook Salmon floodplain usage in the Yolo Bypass; and (8) salmonid genetics. The resulting data would be used to quantify the timing, distribution, and survival of salmon and steelhead migrating through the Delta. This information is imperative to understanding the complex interactions among water operations, abiotic and biotic conditions in the Delta, and population dynamics of species of management concern. The researchers are proposing to kill a subset of larval and hatchery-origin juvenile ESA-listed fish and, though it is not intended, a small number of juveniles and adults of all salmon and steelhead species may also be killed as an inadvertent result of the proposed sampling activities.

Permit 14516-3R

San Jose State University is seeking to renew for five years a permit that currently allows them to annually take juvenile and adult CCC coho salmon and steelhead while conducting research in Gazos Creek, Waddell Creek, Scott Creek, Pescadero Creek Lagoon, and San Gregorio Lagoon on the central coast of California. Fish would be captured (using beach seines and backpack electrofishing), handled (weighed, measured, and checked for marks or tags), and released. A subsample of juvenile and all adult fish from both species would be marked and/or sampled for biological tissues. Carcasses would also be measured and sampled for biological tissues during spawning surveys. The purpose of the research is to continue monitoring coho salmon and steelhead year-to-year abundance, habitat utilization patterns, growth rates, and relative abundance among rearing life-history patterns. The resulting data would be used to guide management actions (including hatchery smolt releases) and help evaluate the relative importance of habitat types and how the interaction between coho salmon and steelhead affects juvenile rearing. The researchers are not proposing to kill any fish, but a small number of juveniles may be killed as an inadvertent result of these activities.

Permit 14808-5R

The CDFW is seeking to renew for five years a permit that currently allows them to annually take juvenile and adult SacR WR Chinook salmon, CVS Chinook salmon, CCV steelhead, and sDPS green sturgeon while conducting research in the Sacramento River in the California Central Valley. Fish would be captured (using rotary screw traps, fyke traps, and beach seines), handled (weighed, measured, and checked for marks or tags), and released. The majority of the juvenile and adult fish from all species would be marked and/or sampled for biological tissues and a subsample would be anesthetized and tagged (PIT, elastomer, or acoustic tag). A further subsample of hatchery-origin juvenile Sacramento River Chinook salmon would be intentionally lethally taken for coded wire tag recovery. Juvenile and adult Chinook salmon and steelhead would also be observed through snorkel and video/DIDSON surveys. The purpose of the research is to monitor—in real time—juvenile salmonid outmigration. It is also intended to evaluate how environmental conditions affect downstream juvenile movement, estimate steelhead population abundance, trends, and spatial distribution in the Central Valley, and document spawning activity and relative abundance of juvenile salmonids in recently restored habitat. The resulting data would be used to help manage downstream gates and water intakes in ways designed to reduce juvenile entrainment. The data would also be used to help managers develop recommendations for steelhead monitoring programs in support of species recovery and evaluate restoration project outcomes. The researchers are proposing to kill a subset of hatchery-origin juvenile ESA-listed fish captured, and a small number of juveniles of all species may be killed as an inadvertent result of sampling activities. The researchers are not proposing to kill any adult fish, but a small number may be killed as an inadvertent result of these activities.

Permit 15215-2R

The CDFW is seeking to renew for five years a permit that currently allows them to annually take juvenile and adult SacR WR Chinook salmon, CCC coho salmon, and SC steelhead anywhere in the State of California and its waters. This permit only allows the CDFW researchers to take dead or moribund fish in the event of an observed fish die-off. Dead or moribund fish found during such an event would be collected and tissue-sampled. Animals determined to be moribund due to such an event would be collected by hand- or dip-net and euthanized before being tissue-sampled. The collected tissue samples would be evaluated for pathogens, immunological response, or DNA testing. The purpose of the research is to understand the role of disease when fish die-off events occur. Data identifying die-off causes would be used to inform fishery and water resource management in ways designed to help avoid such events in the future. The researchers are not proposing to capture or kill any healthy live fish; only dead fish and those that CDFW pathologists or veterinarians determine are severely compromised and unlikely to survive would be taken.

Permit 15390-2R

The RCD of the Santa Monica Mountains is seeking to renew for five years a permit that currently allows them to annually take juvenile and adult SC steelhead in Topanga Creek and Malibu Creek in Los Angeles County, California. Fish would be captured (using backpack electrofishing, fyke traps, and minnow traps), handled (weighed, measured, and checked for marks or tags), and released. A subsample of juveniles would be anesthetized, PIT-tagged, and sampled for biological tissues or stomach contents. The purpose of the research is to document the status of the population of Southern California steelhead in the coastal creeks of Santa Monica Bay, understand outmigration patterns, identify habitat constraints and restoration opportunities, and identify pathogens or diseases related to fish die-off events. The resulting data would be used to evaluate smolt production, recruitment, and seasonal habitat use in Topanga Creek and assess the contribution of various pathogens and diseases to mortality in Malibu creek. The researchers are not proposing to kill any fish, but a small number of juveniles may be killed as an inadvertent result of these activities.

Permit 16122-3R

The CCT are seeking to renew for five years a permit that currently allows them to take juvenile UCR steelhead in the Okanogan River, Washington. The purpose of the research is to monitor steelhead populations in the basin. The researchers are seeking to estimate natural production and productivity and calculate annual population estimates, egg-to-emigrant survival, and emigrant-to-adult survival rates. The population estimates would be used to evaluate the effects of supplementation programs in the Okanogan River Basin and provide mangers with the data they need to determine spawning success. The research would benefit the fish by giving state and Federal managers information on UCR steelhead status and the degree to which they are being affected by supplementation programs in the area. The fish would be captured at screw trapping sites on the Okanogan River. All captured fish would be identified and checked for marks and tags. A subsample of selected fish would be measured and weighed before being released back into the Okanogan River. A further subsample would be marked with a brown dye, released upstream of the screw traps, and recaptured for the purpose of determining trap efficiency. The researchers do not intend to kill any listed salmonids, but a small number may die as an unintended result of the activities.

Permit 16290-4R

The ODFW is seeking to renew for five years a permit that currently authorizes them to take listed salmonids while conducting research on the Oregon chub. The purpose of the research is to study the distribution, abundance, and factors limiting the recovery of Oregon chub. The ODFW would capture, handle, and release juvenile UWR Chinook salmon, UWR steelhead, LCR Chinook salmon, LCR steelhead, LCR coho salmon, and CR chum salmon while conducting the research. The Oregon chub is endemic to the Willamette Valley of Oregon and the habitats it depends on are important to salmonids. Research on the Oregon chub would benefit listed salmonids by helping managers recover habitats that the species share. The ODFW researchers would use boat electrofishing equipment, minnow traps, beach seines, dip nets, hoop nets, and fyke nets to capture juvenile fish. Researchers would avoid contact with adult fish. If listed salmonids are captured during the research they would be released immediately. The researchers do not expect to kill any listed salmonids but a small number may die as an unintended result of the research activities.

Permit 16417-3M

The Santa Clara Valley Water District is seeking to modify a permit that allows them to annually take juvenile and adult CCC steelhead and juvenile SCCC steelhead in the Guadalupe River, Coyote Creek, and Stevens Creek Watershed, Pajaro Watershed, and Lake Almaden in North Santa Clara County, California. In addition to the currently authorized take, the applicants are requesting additional take of juvenile CCC steelhead and juvenile SCCC steelhead in order to add new sampling areas and adjust for numbers of fish encountered while sampling in prior years. Fish would be captured (using backpack electrofishing, boat electrofishing, and beach seines), handled (weighed, measured, and checked for marks or tags), and released. A subsample of juveniles would be anesthetized, PIT-tagged, and sampled for biological tissues. No additional take is being requested for adult fish. The purpose of the research is to collect data on steelhead distribution, habitat use, survival rates, and movements. The resulting data would be used to fill knowledge gaps regarding steelhead distribution and relative abundance in Santa Clara County and help better align water district operations and fisheries management. The researchers are not proposing to kill any fish, but a small number of juveniles may be killed as an inadvertent result of these activities.

Permit 17063-3R

The USFS is seeking to renew for five years a permit that currently allows them to annually take juvenile SONCC coho salmon, NC steelhead, and CC Chinook salmon in the Mad River, Lower Eel River, Van Duzen River, and Weaver Creek drainage in the Mad-Redwood, Lower Eel, and Trinity River sub-basins of coastal Northern California. Fish would be captured (using backpack electrofishing), handled (anesthetized, weighed, measured, and checked for marks or tags), and released. A subsample of SONCC coho would be PIT-tagged. The purpose of the research is to continue building long-term physical and biological data sets that would be used to develop an individual-based model of anadromous salmonids in Weaver Creek and monitor the distribution of non-native speckled dace in the Mad River and Eel River drainages. The resulting data would be used to assess the effectiveness of habitat restoration projects completed in recent years and study why speckled dace have not expanded their range in the Eel River. The researchers are not proposing to kill any fish, but a small number of individuals may be killed as an inadvertent result of these activities.

Permit 17272-2R

The USFWS is seeking to renew for five years a permit that currently allows them to annually take juvenile and adult SONCC coho salmon in the mainstem Klamath River in Northern California. Adult fish would be observed during spawning surveys, and tissue samples would be collected from spawned adult carcasses. Juvenile fish would be captured (using rotary screw traps, fyke traps, and beach seines), handled (weighed, measured, and checked for marks or tags), and released. The purpose of the research is to assess population status, health, habitat use, and mechanisms influencing disease in fish populations of the Klamath River Basin. The resulting data would be used to help managers understand the effects of flow and temperature conditions and timing on disease, the importance of specific habitats to aquatic species, the response of aquatic habitats to restoration actions, and how aquatic habitat is affected by human interaction. The researchers are not proposing to kill any fish, but a small number of juvenile fish may be killed as an inadvertent result of these activities.

Permit 17867-2R

The HRC is seeking to renew for five years a permit that currently allows them to annually take juvenile and adult SONCC coho salmon, NC steelhead, and CC Chinook salmon in the Lower Eel River, Van Duzen River, Freshwater Creek, Elk River, Mattole River, and Bear River in Humboldt County, California. Adult and juvenile fish would be observed via snorkel survey, and a subset of juvenile SONCC coho and NC steelhead would be captured (using backpack electrofishing), handled (weighed, measured, and checked for marks or tags), and released. The purpose of the research is to determine the occurrence, distribution, population abundance, and habitat conditions of listed salmonids on HRC lands. The resulting data would be used to monitor, protect, restore and enhance the anadromous fishery resources in watersheds owned by HRC. The researchers are not proposing to kill any fish, but a small number of juvenile fish may be killed as an inadvertent result of these activities.

Permit 18921-2R

The SINDNR is seeking to renew for five years a research permit that currently allows them to annually take juvenile PS Chinook salmon and PS steelhead. The SINDNR research may also cause them to take adult sDPS eulachon, for which there are currently no ESA take prohibitions. The sampling would take place in the marine waters adjacent to Cypress Island (of the San Juan Island archipelago) in Secret Harbor (Skagit County, WA). Secret Harbor restoration (2008-2018) involved the restoration of an agricultural field to its historical form by breaching an existing tidal dike, restoring tidal exchange and freshwater stream connectivity to the area, and replacing invasive plant species with native vegetation. The restored estuary and salt marsh habitats are expected to enhance and improve structural habitat complexity and potentially support a greater diversity of species. The purpose of the study is to determine fish presence both within and around the Secret Harbor estuary restoration site to continue studying the effectiveness of the restoration efforts. This research would benefit the affected species by informing future restoration designs and providing data to support future enhancement projects. The SINDAR proposes to capture fish using beach seines during year-round monthly sampling events. Fish would be captured, identified to species, measured, and released. The researchers do not propose to kill any of the listed fish being captured, but a small number may die as an unintended result of the activities.

Permit 18937-3R

The Scripps Institute of Oceanography is seeking to renew for five years a permit that allows them to annually take juvenile and adult CC Chinook salmon, CCC coho salmon, and CCC steelhead in tributaries of the Russian River in Mendocino and Sonoma counties, California. Adult fish would be observed via snorkel surveys or spawning surveys, and tissue samples would be collected from carcasses found during spawning surveys. If any adults were to be unintentionally captured in juvenile sampling gear, they would immediately be released. Juvenile fish would also be observed via snorkel surveys and a subset would be captured (using backpack electrofishing, hand- or dip-nets, funnel/pipe traps, and minnow traps), handled (anesthetized, weighed, measured, and checked for marks or tags), and released. A subsample would be anesthetized and PIT-tagged, have tissue samples taken, or have stomach contents sampled (non-lethally). The purpose of the research is to estimate salmonid population metrics such as abundance, survival, growth, and spatial distribution of multiple life stages in the Russian River watershed. The resulting data would be used to provide resource agencies with information relating to population metrics and thereby help them plan recovery actions such as hatchery releases, habitat enhancement projects, and stream flow improvement projects. The researchers are not proposing to kill any fish, but a small number of juveniles and post-spawn steelhead (kelts) may be killed as an inadvertent result of these activities.

Permit 19121-2R

The USGS is seeking to renew for five years a permit that allows them to annually take juvenile and adult SacR WR Chinook salmon, CVS Chinook salmon, CCV steelhead, and adult sDPS green sturgeon in the north San Francisco Bay Delta (including the general Cache Slough complex, Little Holland Tract, and the Sacramento Deep Water Shipping Channel) downstream to the upper San Francisco Estuary in the vicinity of Suisun Bay in the San Francisco Estuary and Sacramento-San Joaquin Delta, California. Salmonids would be captured (using boat electrofishing, fyke nets, gill nets, zooplankton nets, midwater trawls, otter trawls, and beach seines), handled (weighed, measured, and checked for marks or tags), and released. Any green sturgeon adults captured as a result of longline sampling would be anesthetized, PIT-tagged, and would be sampled for biological tissues prior to release. The purpose of this research is to study how physical and biological factors relate to fish assemblages and populations—particularly with regard to the distribution of delta smelt in tidal wetlands in the San Francisco Estuary and Delta. The resulting data would be used to address potential benefits of habitat restoration, specifically by identifying habitat characteristics in restored sites that are associated with plankton production sufficient to establish a food web supporting native fish populations. The data would also help researchers develop new research tools for studying delta smelt. The researchers are not proposing to kill any ESA-listed fish, but a small number of adult and juvenile fish may be killed as an inadvertent result of these activities. In addition, a small number of juvenile non-ESA listed (*i.e.*, fall-run) Chinook salmon would also be intentionally sacrificed for stomach contents analysis, and a small number of juvenile CVS Chinook salmon may be killed as part of this effort in the unlikely event that they are misidentified.

Permit 23649

Mount Hood Environmental is seeking a five-year permit that would allow them to annually take juvenile MCR steelhead from a non-essential experimental population in the Crooked River (Deschutes River watershed) in central Oregon. The researchers would use backpack electrofishing units and screw traps to capture the fish, which would then be measured, weighed, checked for marks and tags, allowed to recover, and released back to the river. A subsample of the captured fish may also be tissue-sampled for genetic assays. The purpose of the research is to establish baseline population information (presence, abundance, density, etc.) on MCR steelhead and native redband trout in the vicinity of Bowman Dam, on the Crooked River. The MCR steelhead that currently occupy the action area are technically part of what is considered to be a nonessential experimental population (NEP). Taking members of this population for scientific purposes is permitted by regulation at 50 CFR 223.301 and, for the sake of analysis, they are considered part of the listed MCR steelhead DPS. The reason for that is that the NEP will expire on January 15, 2025—at which point the population will simply be considered part of the MCR steelhead DPS (although it should be noted the NEP abundance is not currently counted along with the rest of the DPS). The proposed work considered in this opinion will benefit the species by helping managers maintain and operate Bowman Dam (and a possible new hydroelectric turbine proposed for construction there) in the most fish-friendly manner possible. The researchers do not intend to kill any of the fish being captured, but a small number may die as an unintended result of the activities.

Permit 23843

The SRSC is seeking a five-year permit to capture juvenile PS Chinook salmon and PS steelhead in the Skagit River floodplain between river miles 54 and 79 (Skagit County, WA). The purpose of the study is to evaluate a restoration action designed to reconnect 1,700 acres of Skagit River floodplain (Barnaby Slough) by monitoring its effect upon salmonid densities and productivity. Barnaby Slough was used as a rearing pond for hatchery steelhead by the Washington Department of Fish and Wildlife from the 1960's until 2007 and includes three dams, numerous dikes, and a smaller enclosed rearing pond. These features modify flow conditions and block fish passage to the slough and are slated for removal and restoration. This study will employ a Before-After-Control-Impact design with two years of pre-project and three years of post-project monitoring to evaluate fish and habitat relationships. This research would benefit the affected species by informing future restoration designs as well as providing impetus for future enhancement projects. The SRSC proposes to capture fish using fence-weir smolt traps and backpack and boat electrofishing equipment. Fish would be captured, identified to species, measured, fin clipped (caudal fin), dyed, and released. Observational methods such as snorkel and redd surveys would be used to inform and supplement the above methods. The researchers do not propose to kill any of the listed fish being captured, but a small number may die as an unintended result of the activities.

Common Elements among the Proposed Permit Actions

Research permits lay out the conditions to be followed before, during, and after the research activities are conducted. These conditions are intended to (a) manage the interaction between scientists and listed salmonids by requiring that research activities be coordinated among permit holders and between permit holders and NMFS, (b) minimize impacts on listed species, and (c) ensure that NMFS receives information about the effects the permitted activities have on the species concerned. All research permits the NMFS' WCR issues have the following conditions:

1. The permit holder must ensure that listed species are taken only at the levels, by the means, in the areas and for the purposes stated in the permit application, and according to the terms and conditions in the permit.

2. The permit holder must not intentionally kill or cause to be killed any listed species unless the permit specifically allows intentional lethal take.

3. The permit holder must handle listed fish with extreme care and keep them in cold water to the maximum extent possible during sampling and processing procedures. When fish are transferred or held, a healthy environment must be provided; e.g., the holding units must contain adequate amounts of well-circulated water. When using gear that captures a mix of species, the permit holder must process listed fish first to minimize handling stress.

4. The permit holder must stop handling listed juvenile fish if the water temperature exceeds 70 degrees Fahrenheit (°F) at the capture site. Under these conditions, listed fish may only be visually identified and counted. In addition, electrofishing is not permitted if water temperature exceeds 64°F.

5. If the permit holder anesthetizes listed fish to avoid injuring or killing them during handling, the fish must be allowed to recover before being released. Fish that are only counted must remain in water and not be anesthetized.

6. The permit holder must use a sterilized needle for each individual injection when passive integrated transponder tags (PIT-tags) are inserted into listed fish.

7. If the permit holder unintentionally captures any listed adult fish while sampling for juveniles, the adult fish must be released without further handling and such take must be reported.

8. The permit holder must exercise care during spawning ground surveys to avoid disturbing listed adult salmonids when they are spawning. Researchers must avoid walking in salmon streams whenever possible, especially where listed salmonids are likely to spawn. Visual observation must be used instead of intrusive sampling methods, especially when the only activity is determining fish presence.

9. The permit holder using backpack electrofishing equipment must comply with NMFS' Backpack Electrofishing Guidelines (June 2000) (NMFS 2000).

10. The permit holder must obtain approval from NMFS before changing sampling locations or research protocols.

11. The permit holder must notify NMFS as soon as possible but no later than two days after any authorized level of take is exceeded or if such an event is likely. The permit holder must submit a written report detailing why the authorized take level was exceeded or is likely to be exceeded.

12. The permit holder is responsible for any biological samples collected from listed species as long as they are used for research purposes. The permit holder may not transfer biological samples to anyone not listed in the application without prior written approval from NMFS.

13. The person(s) actually doing the research must carry a copy of this permit while conducting the authorized activities.

14. The permit holder must allow any NMFS employee or representative to accompany field personnel while they conduct the research activities.

15. The permit holder must allow any NMFS employee or representative to inspect any records or facilities related to the permit activities.

16. The permit holder may not transfer or assign this permit to any other person as defined in section 3(12) of the ESA. This permit ceases to be in effect if transferred or assigned to any other person without NMFS' authorization.

17. NMFS may amend the provisions of this permit after giving the permit holder reasonable notice of the amendment.

18. The permit holder must obtain all other Federal, state, and local permits/authorizations needed for the research activities.

19. On or before January 31st of every year, the permit holder must submit to NMFS a post-season report in the prescribed form describing the research activities, the number of listed fish taken and the location, the type of take, the number of fish intentionally killed and unintentionally killed, the take dates, and a brief summary of the research results. The report must be submitted electronically on the APPS permit website where downloadable forms can also be found. Falsifying annual reports or permit records is a violation of this permit.

20. If the permit holder violates any permit condition, they will be subject to any and all penalties provided by the ESA. NMFS may revoke this permit if the authorized activities are not

conducted in compliance with the permit and the requirements of the ESA or if NMFS determines that its ESA section 10(d) findings are no longer valid.

“Permit holder” means the permit holder or any employee, contractor, or agent of the permit holder. Also, NMFS may include conditions specific to the proposed research in the individual permits.

Finally, NMFS will use the annual reports to monitor the actual number of listed fish that are taken every year by scientific research activities and will adjust permitted take levels if they are deemed to be excessive or if cumulative take levels rise to the point where they are detrimental to the listed species.

2. ENDANGERED SPECIES ACT: BIOLOGICAL OPINION AND INCIDENTAL TAKE STATEMENT

The ESA establishes a national program for conserving threatened and endangered species of fish, wildlife, plants, and the habitat upon which they depend. As required by section 7(a)(2) of the ESA, each Federal agency must ensure that its actions are not likely to jeopardize the continued existence of endangered or threatened species, or adversely modify or destroy their designated critical habitat. Per the requirements of the ESA, Federal action agencies consult with NMFS and section 7(b)(3) requires that, at the conclusion of consultation, NMFS provide an opinion stating how the agency's actions would affect listed species and their critical habitats. If incidental take is reasonably certain to occur, section 7(b)(4) requires NMFS to provide an ITS that specifies the impact of any incidental taking and includes non-discretionary reasonable and prudent measures (RPMs) and terms and conditions to minimize such impacts.

This opinion constitutes formal consultation and an analysis of effects solely for the evolutionarily significant units (ESUs) and distinct population segments (DPSs) that are the subject of this opinion.[1] Herein, the NMFS determined that the proposed action of issuing 17 scientific research permits, individually or in aggregate:

- May adversely affect PS, LCR, UWR, CC, SacR WR, and CVS Chinook salmon; LCR, SONCC, and CCC coho salmon; CR chum salmon; PS, UCR, LCR, UWR, NC, CCV, CCC, SCCC, and SC steelhead, as well as the Deschutes River NEP of MCR steelhead; sDPS eulachon; and sDPS green sturgeon—but would not jeopardize the continued existence of any of them.
- Is not likely to adversely affect SRKWs or their designated critical habitat. This conclusion is documented in the "Not Likely to Adversely Affect" Determinations section (Section 2.11).

2.1 Analytical Approach

This biological opinion includes both a jeopardy analysis and an adverse modification analysis. The jeopardy analysis relies upon the regulatory definition of "jeopardize the continued existence of" a listed species, which is "to engage in an action that reasonably would be expected, directly or indirectly, to reduce appreciably the likelihood of both the survival and recovery of a listed species in the wild by reducing the reproduction, numbers, or distribution of that species" (50 CFR402.02). Therefore, the jeopardy analysis considers both survival and recovery of the species.

This biological opinion relies on the definition of "destruction or adverse modification," which "means a direct or indirect alteration that appreciably diminishes the value of critical habitat as a whole for the conservation of a listed species" (50 CFR 402.02).

The critical habitat designations for many of the species considered here use the term primary constituent element (PCE) or essential features. The 2016 critical habitat regulations (50 CFR

[1] An ESU of Pacific salmon (Waples 1991) and a DPS of steelhead (71 FR 834), rockfish, eulachon, etc., are considered to be "species" as the word is defined in section 3 of the ESA.

424.12) replaced this term with physical or biological features (PBFs). The shift in terminology does not change the approach used in conducting a ‘‘destruction or adverse modification’’ analysis, which is the same regardless of whether the original designation identified PCEs, PBFs, or essential features. In this biological opinion, we use the term PBF to mean PCE or essential feature, as appropriate for the specific critical habitat.

The 2019 regulations define effects of the action using the term “consequences” (50 CFR 402.02). As explained in the preamble to the regulations (84 FR 44977), that definition does not change the scope of our analysis and in this opinion we use the terms “effects” and “consequences” interchangeably.

We use the following approach to determine whether a proposed action is likely to jeopardize listed species or destroy or adversely modify critical habitat:

- Evaluate the rangewide status of the species and critical habitat expected to be adversely affected by the proposed action.
- Evaluate the environmental baseline of the species and critical habitat.
- Evaluate the effects of the proposed action on species and their habitat using an exposure-response approach.
- Evaluate cumulative effects.
- In the integration and synthesis, add the effects of the action and cumulative effects to the environmental baseline, and, in light of the status of the species and critical habitat, analyze whether the proposed action is likely to: (1) directly or indirectly reduce appreciably the likelihood of both the survival and recovery of a listed species in the wild by reducing the reproduction, numbers, or distribution of that species, or (2) directly or indirectly result in an alteration that appreciably diminishes the value of critical habitat as a whole for the conservation of a listed species.
- If necessary, suggest a reasonable and prudent alternative to the proposed action.

2.2 Rangewide Status of the Species and Critical Habitat

This opinion examines the status of each species that would be adversely affected by the proposed action. The status is determined by the level of extinction risk that the listed species face, based on parameters considered in documents such as recovery plans, status reviews, and listing decisions. This informs the description of the species’ likelihood of both survival and recovery. The species status section also helps to inform the description of the species’ current “reproduction, numbers, or distribution” as described in 50 CFR 402.02. The opinion also examines the condition of critical habitat throughout the designated area, evaluates the conservation value of the various watersheds and coastal and marine environments that make up the designated area, and the function of the PBFs that are essential for the conservation of the species.

Climate Change

Climate change is likely to play an increasingly important role in determining the abundance and distribution of ESA-listed species and the conservation value of designated critical habitats in the Pacific Northwest. These changes will not be spatially homogeneous across the Pacific Northwest. The largest hydrologic responses are expected to occur in basins with significant snow accumulation, where warming decreases snow pack, increases winter flows, and advances the timing of spring melt (Mote et al. 2014, Mote 2016). Rain-dominated watersheds and those with significant contributions from groundwater may be less sensitive to predicted changes in climate (Tague et al. 2013, Mote et al. 2014).

During the last century, average regional air temperatures in the Pacific Northwest increased by 1-1.4°F as an annual average, and up to 2°F in some seasons (based on average linear increase per decade; Abatzoglou et al. 2014, Kunkel et al. 2013). Warming is likely to continue during the next century as average temperatures are projected to increase another 3 to 10°F, with the largest increases predicted to occur in the summer (Mote et al. 2014). Decreases in summer precipitation of as much as 30% by the end of the century are consistently predicted across climate models (Mote et al. 2014). Precipitation is more likely to occur during October through March, less during summer months, and more winter precipitation will be rain than snow (ISAB 2007, Mote et al. 2013, Mote et al. 2014). Earlier snowmelt will cause lower stream flows in late spring, summer, and fall, and water temperatures will be warmer (ISAB 2007, Mote et al. 2014). Models consistently predict increases in the frequency of severe winter precipitation events (i.e., 20-year and 50-year events), in the western United States (Dominguez et al. 2012). The largest increases in winter flood frequency and magnitude are predicted in mixed rain-snow watersheds (Mote et al. 2014).

Overall, about one-third of the current cold-water salmonid habitat in the Pacific Northwest is likely to exceed key water temperature thresholds by the end of this century (Mantua et al. 2009). Higher temperatures will reduce the quality of available salmonid habitat for most freshwater life stages (ISAB 2007). Reduced flows will make it more difficult for migrating fish to pass physical and thermal obstructions, limiting their access to available habitat (Mantua et al. 2010; Isaak et al. 2012). Temperature increases shift timing of key life cycle events for salmonids and species forming the base of their aquatic foodwebs (Crozier et al. 2011, Tillmann and Siemann 2011, Winder and Schindler 2004). Higher stream temperatures will also cause decreases in dissolved oxygen and may also cause earlier onset of stratification and reduced mixing between layers in lakes and reservoirs, which can also result in reduced oxygen (Meyer et al. 1999, Winder and Schindler 2004, Raymondi et al. 2013). Higher temperatures are likely to cause several species to become more susceptible to parasites, disease, and higher predation rates (Crozier et al. 2008; Wainwright and Weitkamp 2013; Raymondi et al. 2013).

As more basins become rain-dominated and prone to more severe winter storms, higher winter stream flows may increase the risk that winter or spring floods in sensitive watersheds will damage spawning redds and wash away incubating eggs (Goode et al. 2013). Earlier peak stream flows will also alter migration timing for salmon smolts, and may flush some young salmon and steelhead from rivers to estuaries before they are physically mature, increasing stress and reducing smolt survival (McMahon and Hartman 1989; Lawson et al. 2004).

In addition to changes in freshwater conditions, predicted changes for coastal waters in the Pacific Northwest as a result of climate change include increasing surface water temperature, increasing but highly variable acidity, and increasing storm frequency and magnitude (Mote et al. 2014). Elevated ocean temperatures already documented for the Pacific Northwest are highly likely to continue during the next century, with sea surface temperature projected to increase by 1.0-3.7ºC (1.8-6.7ºF) by the end of the century (IPCC 2014). Habitat loss, shifts in species' ranges and abundances, and altered marine food webs could have substantial consequences to anadromous, coastal, and marine species in the Pacific Northwest (Tillmann and Siemann 2011, Reeder et al. 2013).

In California, average summer air temperatures are expected to increase according to modeling of climate change impacts (Lindley et al. 2007). Heat waves are expected to occur more often, and heat wave temperatures are likely to be higher (Hayhoe et al. 2004). Total precipitation in California may decline, critically dry years may increase (Lindley et al. 2007, Schneider 2007). Events of both extreme precipitation and intense aridity are projected for California, increasing climactic volatility throughout the state (Swain et al. 2018). Snow pack is a major contributor to stored and distributed water in the state (Diffenbaugh et al. 2015), but this important water source is becoming increasingly threatened. The Sierra Nevada snow pack is likely to decrease by as much as 70 to 90% by the end of this century under the highest emission scenarios modeled (Luers et al. 2006). California wildfires are expected to increase in frequency and magnitude, with 77% more area burned by 2099 under a high emission scenario model (Westerling 2018). Vegetative cover may also change, with decreases in evergreen conifer forest and increases in grasslands and mixed evergreen forests. The likely change in amount of rainfall in Northern and Central Coastal California streams under various warming scenarios is less certain, although as noted above, total rainfall across the state is expected to decline.

For the California North Coast, some models show large increases in precipitation (75 to 200%) while other models show decreases of 15 to 30% (Hayhoe et al. 2004). Many of these changes are likely to further degrade salmonid habitat by, for example, reducing stream flows during the summer and raising summer water temperatures (Williams et al. 2016). Estuaries may also experience changes detrimental to salmonids and green sturgeon. Estuarine productivity is likely to change based on alterations to freshwater flows, nutrient cycling, and sedimentation (Scavia et al. 2002). In marine environments, ecosystems and habitats important to subadult and adult green sturgeon and salmonids are likely to experience changes in temperatures, circulation and chemistry, and food supplies (Feely et al. 2004, Brewer 2008, Osgood 2008, Turley 2008), which would be expected to negatively affect marine growth and survival of listed fish. The projections described above are for the mid- to late-21st Century. In shorter time frames, climate conditions not caused by the human addition of carbon dioxide to the atmosphere are more likely to predominate (Cox and Stephenson 2007, Smith et al. 2007).

Moreover, as atmospheric carbon emissions increase, increasing levels of carbon are absorbed by the oceans, changing the pH of the water. Acidification also impacts sensitive estuary habitats, where organic matter and nutrient inputs further reduce pH and produce conditions more corrosive than those in offshore waters (Feely et al. 2012, Sunda and Cai 2012).

Global sea levels are expected to continue rising throughout this century, reaching likely predicted increases of 10-32 inches by 2081-2100 (IPCC 2014). These changes will likely result in increased erosion and more frequent and severe coastal flooding, and shifts in the composition of nearshore habitats (Tillmann and Siemann 2011, Reeder et al. 2013). Estuarine-dependent salmonids such as chum and Chinook salmon are predicted to be impacted by significant reductions in rearing habitat in some Pacific Northwest coastal areas (Glick et al. 2007). Historically, warm periods in the coastal Pacific Ocean have coincided with relatively low abundances of salmon and steelhead, while cooler ocean periods have coincided with relatively high abundances, and therefore these species are predicted to fare poorly in warming ocean conditions (Scheuerell and Williams 2005; Zabel et al. 2006). This is supported by the recent observation that anomalously warm sea surface temperatures off the coast of Washington from 2013 to 2016 resulted in poor coho and Chinook salmon body condition for juveniles caught in those waters (NWFSC 2015). Changes to estuarine and coastal conditions, as well as the timing of seasonal shifts in these habitats, have the potential to impact a wide range of listed aquatic species (Tillmann and Siemann 2011, Reeder et al. 2013).

The adaptive ability of these threatened and endangered species is depressed due to reductions in population size, habitat quantity and diversity, and loss of behavioral and genetic variation. Without these natural sources of resilience, systematic changes in local and regional climatic conditions will likely reduce long-term viability and sustainability of populations in many of these ESUs (NWFSC 2015). New stressors generated by climate change, or existing stressors with effects that have been amplified by climate change, may also have synergistic impacts on species and ecosystems (Doney et al. 2012). These conditions will possibly intensify the climate change stressors inhibiting recovery of ESA-listed species in the future.

2.2.1 Status of the Species

For Pacific salmon and steelhead, NMFS commonly uses four parameters to assess the viability of the populations that, together, constitute the species: spatial structure, diversity, abundance, and productivity (McElhany et al. 2000). These "viable salmonid population" (VSP) criteria therefore encompass the species' "reproduction, numbers, or distribution" as described in 50 CFR 402.02. We apply the same criteria for other species as well, but in those instances, they are not referred to as "salmonid" population criteria. When any animal population or species has sufficient spatial structure, diversity, abundance, and productivity, it will generally be able to maintain its capacity to adapt to various environmental conditions and sustain itself in the natural environment.

"Spatial structure" refers both to the spatial distributions of individuals in the population and the processes that generate that distribution. A population's spatial structure depends fundamentally on habitat quality and spatial configuration and the dynamics and dispersal characteristics of individuals in the population.

"Diversity" refers to the distribution of traits within and among populations. These range in scale from DNA sequence variation at single genes to complex life history traits (McElhany et al. 2000).

"Abundance" generally refers to the number of naturally-produced adults (i.e., the progeny of naturally-spawning parents) in the natural environment (e.g., on spawning grounds).

"Productivity," as applied to viability factors, refers to the entire life cycle; i.e., the number of naturally-spawning adults produced per parent. When progeny replace or exceed the number of parents, a population is stable or increasing. When progeny fail to replace the number of parents, the population is declining. McElhany et al. (2000) use the terms "population growth rate" and "productivity" interchangeably when referring to production over the entire life cycle. They also refer to "trend in abundance," which is the manifestation of long-term population growth rate.

For species with multiple populations, once the biological status of a species' populations has been determined, NMFS assesses the status of the entire species using criteria for groups of populations, as described in recovery plans and guidance documents from technical recovery teams. Considerations for species viability include having multiple populations that are viable, ensuring that populations with unique life histories and phenotypes are viable, and that some viable populations are both widespread to avoid concurrent extinctions from mass catastrophes and spatially close enough to allow them to function as metapopulations (McElhany et al. 2000).

A species' status thus is a function of how well its biological requirements are being met: the greater the degree to which the requirements are fulfilled, the better the species' status. Information on the status and distribution of all the species considered here can be found in a number of documents, but the most pertinent are the status review updates and recovery plans listed in Table 2 and the specific species sections that follow. These documents and other relevant information may be found on the NOAA Fisheries West Coast Region website; the discussions they contain are summarized in the tables below. For the purposes of our later analysis, all the species considered here require functioning habitat and adequate spatial structure, abundance, productivity, and diversity to ensure their survival and recovery in the wild.

Table 2. Listing classification and date, recovery plan reference, most recent status review, status summary, and limiting factors for each species considered in this opinion.

Species	Listing Classification and Date	Recovery Plan Reference	Most Recent Status Review	Status Summary	Limiting Factors
Puget Sound Chinook salmon	Threatened 06/28/2005 (70 FR 37160)	SSDC 2007 NMFS 2006	NWFSC 2015	This ESU comprises 22 populations distributed over five geographic areas. Most populations within the ESU have declined in abundance over the past 7 to 10 years, with widespread negative trends in natural-origin spawner abundance, and hatchery-origin spawners present in high fractions in most populations outside of the Skagit watershed. Escapement levels for all populations remain well below the Technical Recovery Team (TRT) planning ranges for recovery, and most populations are consistently below the spawner-recruit levels identified by the TRT as consistent with recovery.	• Degraded floodplain and in-river channel structure • Degraded estuarine conditions and loss of estuarine habitat • Degraded riparian areas and loss of in-river large woody debris • Excessive fine-grained sediment in spawning gravel • Degraded water quality and temperature • Degraded nearshore conditions • Impaired passage for migrating fish • Severely altered flow regime
Puget Sound steelhead	Threatened 05/11/2007 (72 FR 26722)	NMFS 2018a (draft)	NWFSC 2015	This DPS comprises 32 populations. The DPS is currently at very low viability, with most of the 32 populations and all three population groups at low viability. Information considered during the most recent status review indicates that the biological risks faced by the Puget Sound Steelhead DPS have not substantively changed since the listing in 2007, or since the 2011 status review. Furthermore, the Puget Sound Steelhead TRT recently concluded that the DPS was at very low viability, as were all three of its constituent MPGs, and many of its 32 populations. In the near term, the outlook for environmental conditions affecting Puget Sound steelhead is not optimistic. While harvest and hatchery production of steelhead in Puget Sound are currently at low levels and are not likely to increase substantially in the foreseeable future, some recent environmental trends not favorable to Puget Sound steelhead survival and production are expected to continue.	• Continued destruction and modification of habitat • Widespread declines in adult abundance despite significant reductions in harvest • Threats to diversity posed by use of two hatchery steelhead stocks • Declining diversity in the DPS, including the uncertain but weak status of summer-run fish • A reduction in spatial structure • Reduced habitat quality • Urbanization • Dikes, hardening of banks with riprap, and channelization
Upper Columbia River steelhead	Threatened 01/05/2006 (71 FR 834)	UCSRB 2007	NWFSC 2015	This DPS comprises four independent populations. Three populations are at high risk of extinction while 1 population is at moderate	• Adverse effects related to the mainstem Columbia River hydropower system • Impaired tributary fish passage

Species	Listing Classification and Date	Recovery Plan Reference	Most Recent Status Review	Status Summary	Limiting Factors
				risk. Upper Columbia River steelhead populations have increased relative to the low levels observed in the 1990s, but natural-origin abundance and productivity remain well below viability thresholds for three out of the four populations. The status of the Wenatchee River steelhead population continued to improve based on the additional year's information available for the most recent review. The abundance and productivity viability rating for the Wenatchee River exceeds the minimum threshold for 5% extinction risk. However, the overall DPS status remains unchanged from the prior review, remaining at high risk driven by low abundance and productivity relative to viability objectives and diversity concerns.	• Degraded floodplain connectivity and function, channel structure and complexity, riparian areas, large woody debris recruitment, stream flow, and water quality • Hatchery-related effects • Predation and competition • Harvest-related effects
Middle Columbia River steelhead	Threatened 01/05/2006 (71 FR 834)	NMFS 2009b	NWFSC 2015	This DPS comprises 17 extant populations. The DPS does not currently include steelhead that are designated as part of an experimental population above the Pelton Round Butte Hydroelectric Project. Returns to the Yakima River basin and to the Umatilla and Walla Walla Rivers have been higher over the most recent brood cycle, while natural-origin returns to the John Day River have decreased. There have been improvements in the viability ratings for some of the component populations, but the DPS is not currently meeting the viability criteria in the MCR steelhead recovery plan. In general, the majority of population level viability ratings remained unchanged from prior reviews for each major population group within the DPS.	• Degraded freshwater habitat • Mainstem Columbia River hydropower-related impacts • Degraded estuarine and nearshore marine habitat • Hatchery-related effects • Harvest-related effects • Effects of predation, competition, and disease

Species	Listing Classification and Date	Recovery Plan Reference	Most Recent Status Review	Status Summary	Limiting Factors
Lower Columbia River Chinook salmon	Threatened 06/28/2005 (70 FR 37160)	NMFS 2013	NWFSC 2015	This ESU comprises 32 independent populations. Twenty-seven populations are at very high risk, 2 populations are at high risk, one population is at moderate risk, and 2 populations are at very low risk. Overall, there was little change since the last status review in the biological status of this ESU, although there are some positive trends. Increases in abundance were noted in about 70% of the fall-run populations and decreases in hatchery contribution were noted for several populations. Relative to baseline VSP levels identified in the recovery plan, there has been an overall improvement in the status of a number of fall-run populations, although most are still far from the recovery plan goals.	• Reduced access to spawning and rearing habitat • Hatchery-related effects • Harvest-related effects on fall Chinook salmon • An altered flow regime and Columbia River plume • Reduced access to off-channel rearing habitat • Reduced productivity resulting from sediment and nutrient-related changes in the estuary • Contaminant
Lower Columbia River coho salmon	Threatened 06/28/2005 (70 FR 37160)	NMFS 2013	NWFSC 2015	Of the 24 populations that make up this ESU, 21 populations are at very high risk, 1 population is at high risk, and 2 populations are at moderate risk. Recent recovery efforts may have contributed to the observed natural production, but in the absence of longer term data sets it is not possible to parse out these effects. Populations with longer term data sets exhibit stable or slightly positive abundance trends. Some trap and haul programs appear to be operating at or near replacement, although other programs still are far from that threshold and require supplementation with additional hatchery-origin spawners .Initiation of or improvement in the downstream juvenile facilities at Cowlitz Falls, Merwin, and North Fork Dam are likely to further improve the status of the associated upstream populations. While these and other recovery efforts have likely improved the status of a number of coho salmon populations, abundances are still at low levels and the majority of the populations remain at moderate or high risk. For the Lower Columbia River region land development and increasing human population pressures will	• Degraded estuarine and near-shore marine habitat • Fish passage barriers • Degraded freshwater habitat: Hatchery-related effects • Harvest-related effects • An altered flow regime and Columbia River plume • Reduced access to off-channel rearing habitat in the lower Columbia River • Reduced productivity resulting from sediment and nutrient-related changes in the estuary • Juvenile fish wake strandings • Contaminants

Species	Listing Classification and Date	Recovery Plan Reference	Most Recent Status Review	Status Summary	Limiting Factors
				likely continue to degrade habitat, especially in lowland areas. Although populations in this ESU have generally improved, especially in the 2013/14 and 2014/15 return years, recent poor ocean conditions suggest that population declines might occur in the upcoming return years	
Lower Columbia River steelhead	Threatened 01/05/2006 (71 FR 834)	NMFS 2013	NWFSC 2015	This DPS comprises 23 historical populations, 17 winter-run populations and six summer-run populations. Nine populations are at very high risk, 7 populations are at high risk, 6 populations are at moderate risk, and 1 population is at low risk. The majority of winter-run steelhead populations in this DPS continue to persist at low abundances. Hatchery interactions remain a concern in select basins, but the overall situation is somewhat improved compared to prior reviews. Summer-run steelhead populations were similarly stable, but at low abundance levels. The decline in the Wind River summer-run population is a source of concern, given that this population has been considered one of the healthiest of the summer-runs; however, the most recent abundance estimates suggest that the decline was a single year aberration. Passage programs in the Cowlitz and Lewis basins have the potential to provide considerable improvements in abundance and spatial structure, but have not produced self-sustaining populations to date. Even with modest improvements in the status of several winter-run DIPs, none of the populations appear to be at fully viable status, and similarly none of the MPGs meet the criteria for viability.	• Degraded estuarine and nearshore marine habitat • Degraded freshwater habitat • Reduced access to spawning and rearing habitat • Avian and marine mammal predation • Hatchery-related effects • An altered flow regime and Columbia River plume • Reduced access to off-channel rearing habitat in the lower Columbia River • Reduced productivity resulting from sediment and nutrient-related changes in the estuary • Juvenile fish wake strandings • Contaminants
Columbia River chum salmon	Threatened 06/28/2005 (70 FR 37160)	NMFS 2013	NWFSC 2015	Overall, the status of most chum salmon populations is unchanged from the baseline VSP scores estimated in the recovery plan. A total of 3 of 17 populations are at or near their recovery viability goals, although under the recovery plan	• Degraded estuarine and nearshore marine habitat • Degraded freshwater habitat • Degraded stream flow as a result of hydropower and water supply operations

Species	Listing Classification and Date	Recovery Plan Reference	Most Recent Status Review	Status Summary	Limiting Factors
				scenario these populations have very low recovery goals of 0. The remaining populations generally require a higher level of viability and most require substantial improvements to reach their viability goals. Even with the improvements observed during the last five years, the majority of populations in this ESU remain at a high or very high risk category and considerable progress remains to be made to achieve the recovery goals.	• Reduced water quality • Current or potential predation • An altered flow regime and Columbia River plume • Reduced access to off-channel rearing habitat in the lower Columbia River • Reduced productivity resulting from sediment and nutrient-related changes in the estuary • Juvenile fish wake strandings • Contaminants
Upper Willamette River Chinook salmon	Threatened 06/28/2005 (70 FR 37160)	ODFW and NMFS 2011	NWFSC 2015	This ESU comprises seven populations. Five populations are at very high risk, one population is at moderate risk (Clackamas River) and one population is at low risk (McKenzie River). Consideration of data collected since the last status review in 2010 indicates the fraction of hatchery-origin fish in all populations remains high (even in Clackamas and McKenzie populations). The proportion of natural-origin spawners improved in the North and South Santiam basins, but is still well below identified recovery goals. Abundance levels for five of the seven populations remain well below their recovery goals. Of these, the Calapooia River may be functionally extinct and the Molalla River remains critically low. Abundances in the North and South Santiam rivers have risen since the 2010 review, but still range only in the high hundreds of fish. The Clackamas and McKenzie populations have previously been viewed as natural population strongholds, but have both experienced declines in abundance despite having access to much of their historical spawning habitat. Overall, populations appear to be at either moderate or high risk, there has been likely little net change in the VSP score for the ESU since the last review, so the ESU remains at moderate risk.	• Degraded freshwater habitat • Degraded water quality • Increased disease incidence • Altered stream flows • Reduced access to spawning and rearing habitats • Altered food web due to reduced inputs of microdetritus • Predation by native and non-native species, including hatchery fish • Competition related to introduced salmon and steelhead • Altered population traits due to fisheries and bycatch

Species	Listing Classification and Date	Recovery Plan Reference	Most Recent Status Review	Status Summary	Limiting Factors
Upper Willamette River steelhead	Threatened 01/05/2006 (71 FR 834)	ODFW and NMFS 2011	NWFSC 2015	This DPS has four demographically independent populations. Three populations are at low risk and one population is at moderate risk. Declines in abundance noted in the last status review continued through the period from 2010-2015. While rates of decline appear moderate, the DPS continues to demonstrate the overall low abundance pattern that was of concern during the last status review. The causes of these declines are not well understood, although much accessible habitat is degraded and under continued development pressure. The elimination of winter-run hatchery release in the basin reduces hatchery threats, but non-native summer steelhead hatchery releases are still a concern for species diversity and a source of competition for the DPS. While the collective risk to the persistence of the DPS has not changed significantly in recent years, continued declines and potential negative impacts from climate change may cause increased risk in the near future.	• Degraded freshwater habitat • Degraded water quality • Increased disease incidence • Altered stream flows • Reduced access to spawning and rearing habitats due to impaired passage at dams • Altered food web due to changes in inputs of microdetritus • Predation by native and non-native species, including hatchery fish and pinnipeds • Competition related to introduced salmon and steelhead • Altered population traits due to interbreeding with hatchery-origin fish
Southern Oregon/ Northern California Coast coho salmon	Threatened 06/28/2005 (70 FR 37160)	NMFS 2014b	Williams et al. 2015	This ESU comprises 31 independent, 9 independent, and 5 ephemeral populations all grouped into 7 diversity strata. Of the 31 independent populations, 24 are at high risk of extinction and 6 are at moderate risk of extinction. The extinction risk of an ESU depends upon the extinction risk of its constituent independent populations; because the population abundance of most independent populations are below their depensation threshold, the SONCC coho salmon ESU is at high risk of extinction and is not viable	• Lack of floodplain and channel structure • Impaired water quality • Altered hydrologic function • Impaired estuary/mainstem function • Degraded riparian forest conditions • Altered sediment supply • Increased disease/predation/competition • Barriers to migration • Fishery-related effects • Hatchery-related effects
Northern California steelhead	Threatened 6/7/2000 (65 FR 36074)	NMFS 2016a	NMFS 2016b	This DPS historically comprised 42 independent populations of winter-run steelhead (19 functionally independent and 23 potentially independent), and up to 10 independent populations (all functionally independent) of summer-run steelhead, with more than 65	• Dams and other barriers to migration • Logging • Agriculture • Ranching • Fishery-related effects

Species	Listing Classification and Date	Recovery Plan Reference	Most Recent Status Review	Status Summary	Limiting Factors
				dependent populations of winter-run steelhead in small coastal watersheds, and Eel river tributaries. Many populations are considered to be extant. Significant gaps in information exist for the Lower Interior and North Mountain Interior diversity strata. All winter-run populations are currently well below viability targets, with most at 5-13% of these goals. Mixed population trends arise depending on time series length; thus, there is no strong evidence to indicate conditions for winter-run populations have worsened appreciably since the last status review. Summer-run populations are of concern. While one run is near the viability target, others are very small or there is a lack of data. Overall, available information for winter- and summer-run populations do not suggest an appreciable increase or decrease in extinction risk since the last status review.	• Hatchery-related effects
California Coastal Chinook salmon	Threatened 09/16/1999 (64 FR 50394)	NMFS 2016a	Williams et al. 2016	This ESU historically supported 16 Independent populations of fall-run Chinook salmon (11 Functionally Independent and five potentially Independent), six populations of spring-run Chinook salmon, and an unknown number of dependent populations. Based on the data available, eight of the 16 populations were classified as data deficient, one population was classified as being at a Moderate/High risk of extirpation, and six populations were classified as being at a High risk of extirpation. There has been a mix in population trends, with some population escapement numbers increasing and others decreasing. Overall, there is a lack of compelling evidence to suggest that the status of these populations has improved or deteriorated appreciably since the previous status review.	• Logging and road construction altering substrate composition, increasing sediment load, and reducing riparian cover • Estuarine alteration resulting in lost complexity and habitat from draining and diking • Dams and barriers diminishing downstream habitats through altered flow regimes and gravel recruitment • Climate change • Urbanization and agriculture degrading water quality from urban pollution and agricultural runoff • Gravel mining creating barriers to migration, stranding of adults, and promoting spawning in poor locations • Alien species (i.e. Sacramento Pikeminnow) • Small hatchery production without monitoring the effects of hatchery releases on wild spawners

Species	Listing Classification and Date	Recovery Plan Reference	Most Recent Status Review	Status Summary	Limiting Factors
Sacramento River winter-run Chinook salmon	Endangered 09/16/1999 (64 FR 50394)	NMFS 2014a	Williams et al. 2016	This ESU historically supported 18 or 19 Independent populations, with some smaller dependent populations, and four diversity groups. Only three populations are extant (Mill, Deer, and Butte creeks on the upper Sacramento River) which only represent one diversity group (Northern Sierra Nevada). Spatial diversity is increasing with presence (at low numbers in some cases) in all diversity groups. Recolonization of the Battle Creek population with increasing abundance of the Clear Creek population is benefiting ESU viability. The reappearance of phenotypic spring-run to the San Joaquin River tributaries may be the beginning of natural recolonization processes in once extirpated rivers. Active reintroduction efforts on the Yuba and San Joaquin rivers show promise. The ESU is trending positively towards achieving at least two populations in each of the four historical diversity groups necessary for recovery.	• Dams block access to 90 percent of historic spawning and summer holding areas along with altering river flow regimes and temperatures. • Diversions • Urbanization and rural development • Logging • Grazing • Agriculture • Mining – historic hydraulic mining from the California Gold Rush era. • Estuarine modified and degraded, thus reducing developmental opportunities for juvenile salmon • Fisheries • Hatcheries • 'Natural' factors (e.g. ocean conditions)
Central Valley spring-run Chinook salmon	Threatened 09/16/1999 (64 FR 50394)	NMFS 2014a	Williams et al. 2016	This ESU historically supported 18 or 19 Independent populations, with some smaller dependent populations, and four diversity groups. Only three populations are extant (Mill, Deer, and Butte creeks on the upper Sacramento River) which only represent one diversity group (Northern Sierra Nevada). Spatial diversity is increasing with presence (at low numbers in some cases) in all diversity groups. Recolonization of the Battle Creek population with increasing abundance of the Clear Creek population is benefiting ESU viability. The reappearance of phenotypic spring-run to the San Joaquin River tributaries may be the beginning of natural recolonization processes in once extirpated rivers. Active reintroduction efforts on the Yuba and San Joaquin rivers show promise. The ESU is trending positively towards achieving at least	• Dams block access to 90 percent of historic spawning and summer holding areas along with altering river flow regimes and temperatures. • Diversions • Urbanization and rural development • Logging • Grazing • Agriculture • Mining – historic hydraulic mining from the California Gold Rush era. • Estuarine modified and degraded, thus reducing developmental opportunities for juvenile salmon • Fisheries • Hatcheries • 'Natural' factors (e.g. ocean conditions)

Species	Listing Classification and Date	Recovery Plan Reference	Most Recent Status Review	Status Summary	Limiting Factors
				two populations in each of the four historical diversity groups necessary for recovery.	
California Central Valley steelhead	Threatened 3/19/1998 (63 FR 13347)	NMFS 2014a	Williams et al. 2016	Steelhead are present throughout most of the watersheds in the Central Valley, but often in low numbers, especially in the San Joaquin River tributaries. The status of this DPS appears to have changed little since the 2011 status review stating the DPS was in danger of extinction. There is still a paucity of data on the status of wild populations. There are some encouraging signs of increased returns over the last few years. However, the catch of unmarked (wild) steelhead at Chipps Island is still less than 5 percent of the total smolt catch, which indicates natural production of steelhead throughout the Central Valley remains at very low levels. Despite a positive trend on Clear Creek and encouraging signs from Mill Creek, all other concerns raised in the previous status review remain.	• Major dams • Water diversions • Barriers • Levees and bank protection • Dredging and sediment disposal • Mining • Contaminants • Alien species • Fishery-related effects • Hatchery-related effects
Central California Coast coho salmon	Endangered 04/02/2012 (77 FR 19552) 06/28/2005 (70 FR 37160) Threatened 10/31/1996 (61 FR 56138)	NMFS 2012	Williams et al. 2016	This ESU comprises approximately 76 populations that are mostly dependent populations. Historically, the ESU had 11 functionally independent populations and one potentially independent population organized into four stratum. Most independent populations remain at critically low levels, with those in the southern Santa Cruz Mountains strata likely extirpated. Data suggests some populations show a slight positive trend in annual escapement, but the improvement is not statistically significant. Overall, all populations remain, at best, a slight fraction of their recovery target levels, and, aside from the Santa Cruz Mountains strata, the continued extirpation of dependent populations continues to threaten the ESU's future survival and recovery.	• Logging • Agriculture • Mining • Urbanization • Stream modifications - including altered stream bank and channel morphology, elevated water temperature, lost spawning and rearing habitat, habitat fragmentation, impaired gravel and wood recruitment from upstream sources, degraded water quality, lost riparian vegetation, and increased erosion into streams from upland areas • Dams • Wetland loss • Water withdrawals (including unscreened diversions for irrigation)

Species	Listing Classification and Date	Recovery Plan Reference	Most Recent Status Review	Status Summary	Limiting Factors
Central California Coast steelhead	Threatened 8/18/1997 (62 FR 43937)	NMFS 2016a	NMFS 2016c	Both adult and juvenile abundance data are limited for this DPS. It was historically comprised of 37 independent populations (11 functionally independent and 26 potentially independent) and perhaps 30 or more dependent populations of winter-run steelhead. Most of the coastal populations are assumed to be extant with other populations (Coastal San Francisco Bay and Interior San Francisco Bay) likely at high risk of extirpation. While data availability for this DPS remains poor, there is little new evidence to suggest that the extinction risk for this DPS has changed appreciably in either direction since the last status review.	• Dams and other barriers to migration • Stream habitat degradation • Estuarine habitat degradation • Hatchery-related effects
South-Central California Coast steelhead	Threatened 8/18/1997 (62 FR 43937)	NMFS 2013b	NMFS 2016d	Currently, nearly half of this DPS reside in the Carmel River. Most other streams and rivers have small populations that can be stochastically driven to extirpation. The ability to fully assess the status of individual populations and the DPS as whole has been limited. There is little new evidence to indicate that the status of the S-CCC Steelhead DPS has changed appreciably since the last status review, though the Carmel River runs have shown a long term decline. Threats to the DPS identified during initial listing have remained largely unchanged, though some fish passage barriers have been removed. Threats to this DPS are likely to exacerbate the factors affecting the continued existence of the DPS. S-CCC steelhead recovery will require reducing threats, maintaining interconnected populations across their native range, and preserving the diversity of life history strategies.	• Hydrological modifications- dams, surface water diversions, groundwater extraction • Agricultural and urban development, roads, other passage barriers • Flood control, levees, channelization • Alien species • Estuarine habitat loss • Marine environment threats • Natural environmental variability • Pesticide contaminants
Southern California Steelhead	Endangered 8/18/1997 (62 FR 43937)	NMFS 2013b	NMFS 2016d	This DPS includes steelhead populations along the coast of California from the Santa Maria River system to the border between the U.S. and Mexico. In this area there we have counted only a very small number of fish—typically fewer than 12 adults per year on average in	• Loss and degradation of estuarine habitats • Dams • Urban Development, roads • Mining, agriculture, ranching, recreation

Species	Listing Classification and Date	Recovery Plan Reference	Most Recent Status Review	Status Summary	Limiting Factors
				recent years—but we note that there are enduring annual runs. It remains to be seen how these small runs are able to persist. Some populations in different basins are connected by relatively frequent straying. More recent genetic data show a large amount of introgression and extirpation of native fish in the southern portion of this area. There has been progress in removing fish passage barriers and in constructing fish passage in some watersheds. Recovery projects also include plant restoration and removal of non-native species. However, anthropogenic effects are overall unchanged, and impacts from climate change are expected to intensify the threats this species faces.	• Predation by and competition with non-native species • Disease • More frequent and extended river mouth closures • Inadequate regulatory mechanisms • Climate change induced environmental variability
Southern DPS (sDPS) of green sturgeon	Threatened 04/07/2006 (71 FR 17757)	NMFS 2018b	NMFS 2015b	The Sacramento River contains the only known green sturgeon spawning population in this DPS. The current estimate of spawning adult abundance is between 824-1,872 individuals. Telemetry data and genetic analyses suggest that Southern DPS green sturgeon generally occur from Graves Harbor, Alaska to Monterey Bay, California and, within this range, most frequently occur in coastal waters of Washington, Oregon, and Vancouver Island and near San Francisco and Monterey bays. Within the nearshore marine environment, tagging and fisheries data indicate that Northern and Southern DPS green sturgeon prefer marine waters of less than a depth of 110 meters.	• Reduction of its spawning area to a single known population • Lack of water quantity • Poor water quality • Poaching
Southern DPS (sDPS) of eulachon	Threatened 03/18/2010 (75 FR 13012)	NMFS 2017c	Gustafson et al. 2016	The Southern DPS of eulachon includes all naturally-spawned populations that occur in rivers south of the Nass River in British Columbia to the Mad River in California. Sub populations for this species include the Fraser River, Columbia River, British Columbia and the Klamath River. In the early 1990s, there was an abrupt decline in the abundance of eulachon returning to the Columbia River. Despite a brief	• Changes in ocean conditions due to climate change, particularly in the southern portion of the species' range where ocean warming trends may be the most pronounced and may alter prey, spawning, and rearing success. • Climate-induced change to freshwater habitats • Bycatch of eulachon in commercial fisheries

Species	Listing Classification and Date	Recovery Plan Reference	Most Recent Status Review	Status Summary	Limiting Factors
				period of improved returns in 2001-2003, the returns and associated commercial landings eventually declined to the low levels observed in the mid-1990s. Although eulachon abundance in monitored rivers has generally improved, especially in the 2013-2015 return years, recent poor ocean conditions and the likelihood that these conditions will persist into the near future suggest that population declines may be widespread in the upcoming return years	• Adverse effects related to dams and water diversions • Water quality • Shoreline construction • Over harvest • Predation
Southern resident killer whale	Endangered 11/18/2005 (70 FR 69903)	NMFS 2008	Ford 2013	The Southern Resident killer whale DPS is composed of a single population that ranges as far south as central California and as far north as southeast Alaska. The estimated effective size of the population (based on the number of breeding individuals under ideal genetic conditions) is very small — <30 whales, or about 1/3 of the current population size. The small effective population size, the absence of gene flow from other populations, and documented breeding within pods may elevate the risk from inbreeding and other issues associated with genetic deterioration. As of July 1, 2013, there were 26 whales in J pod, 19 whales in K pod and 37 whales in L pod, for a total of 82 whales. Estimates for the historical abundance of Southern Resident killer whales range from 140 whales (based on public display removals to 400 whales, as used in population viability analysis scenarios.	• Quantity and quality of prey • Exposure to toxic chemicals • Disturbance from sound and vessels • Risk from oil spills

Species-specific status information, including abundance estimates by life stage and hatchery or naturally produced fish, is discussed in more detail below. For most of the listed species, we estimate abundance for adult returning fish and outmigrating smolts. These data come from estimates compiled by our Science Centers for species status reviews that are updated every five years. Additional data sources include state agencies, county and local agencies, and educational and non-profit institutions. Information from these sources is vetted for scientific accuracy before it is used.

Estimates of adult abundance often come from annual spawning surveys or counts at dams, weirs, or fish ladders, and may or may not differentiate natural-origin from hatchery-origin fish. For some ESUs and DPSs long-term adult abundance data are available for all or most populations, while others are lacking complete or continuous monitoring data. For hatchery-origin juvenile salmonids, we use hatchery production goals. In many cases estimates of naturally produced outmigrating juveniles are not available from monitoring data, and are instead estimated from adult spawner abundance, any known estimate of spawner fecundity, and average egg to smolt survival rates. These estimates should be viewed with caution, as they only address one of several juvenile life stages. Moreover, deriving any juvenile abundance estimate is complicated by a host of variables, including the facts that: (1) the available data often do not include all populations; (2) spawner counts and associated sex ratios and fecundity estimates can vary widely between years; (3) multiple juvenile age classes (fry, parr, smolt) are present yet comparable data sets may not exist for all of them; (4) survival rates between life stages are often poorly understood and subject to a multitude of natural and human-induced variables (e.g., predation, floods, fishing, etc.); and (5) in the case of steelhead it can be very difficult to distinguish between non-listed juvenile rainbow trout and listed juvenile steelhead (both *O. mykiss*) during surveys.

2.2.1.1 Puget Sound Chinook Salmon

Listed Hatchery Juvenile Releases – Twenty-six artificial propagation programs are part of the species and are also listed (79 FR 20802; Table 2). Juvenile listed hatchery PS Chinook salmon abundance estimates come from the annual hatchery production goals and planned releases (WDFW 2020; Table 3). Hatchery production varies annually due to several factors including funding, equipment failures, human error, disease, and adult spawner availability. Funding uncertainties and the inability to predict equipment failures, human error, and disease suggest that production averages from previous years is not a reliable indication of future production. For these reasons, abundance is assumed to equal production goals. The combined hatchery production goal for listed PS Chinook salmon is 54,843,130 adipose-fin-clipped and non-clipped juvenile Chinook salmon.

Adult spawners and expected outmigration – The current abundance for adult PS Chinook salmon is calculated by summing the five-year geometric mean abundance estimates for all populations' natural- and hatchery-origin spawners (unpublished data, Mindy Rowse, NWFSC, July 14, 2020; Table 3). No populations in this DPS are meeting their minimum viability abundance targets, and only three of 22 populations average greater than 20% of the minimum viability abundance target for natural-origin spawner abundance (all of which are in the Skagit River watershed).

Table 3. Expected annual abundances of PS Chinook salmon spawners and juvenile outmigrants (WDFW 2020, unpublished data from Mindy Rowse, NWFSC, July 14, 2020).

Life Stage	Origin	Abundance
Adult	Natural	21,486
	Listed Hatchery, Clipped and Intact	18,060
Juvenile	Natural[1]	3,163,652
	Listed Hatchery Intact Adipose	7,470,630
	Listed Hatchery Adipose Clip	47,372,500

[1] Expected number of outmigrants=Total spawners*40% proportion of females*2,000 eggs per female*10% survival rate from egg to outmigrant (Healey 1991; Beamer et al. 2000; Seiler et al. 2002, 2004, 2005; Volkhardt et al. 2005; Griffith et al. 2004)

Natural-origin juvenile PS Chinook salmon abundance estimates come from escapement data, the percentage of females in the population, and fecundity. Fecundity estimates for the ESU range from 2,000 to 5,500 eggs per female, and the proportion of female spawners in most populations is approximately 40% of escapement. By applying a conservative fecundity estimate (2,000 eggs/female) to the expected female escapement (both natural-origin and hatchery-origin spawners – 15,818 females), the ESU is estimated to produce approximately 31.6 million eggs annually. Smolt trap studies have researched egg-to-migrant juvenile Chinook salmon survival rates in the following Puget Sound tributaries: Skagit River, North Fork Stillaguamish River, South Fork Stillaguamish River, Bear Creek, Cedar River, and Green River (Beamer et al. 2000; Seiler et al. 2002, 2004, 2005; Volkhardt et al. 2005; Griffith et al. 2004). The average survival rate in these studies was 10%, which corresponds with those reported by Healey (1991). With an estimated survival rate of 10%, the ESU should produce roughly 3.16 million natural-origin outmigrants annually.

2.2.1.2 Puget Sound Steelhead

Listed Hatchery Juvenile Releases – Six artificial propagation programs were listed as part of the DPS (79 FR 20802; Table 4). For 2021, 222,500 hatchery steelhead (adipose clipped and unmarked) are expected to be released throughout the range of the PS steelhead DPS (WDFW 2020).

Adult spawners and expected outmigration – The current abundance for adult PS steelhead is calculated by summing the five-year geometric mean abundance estimates for all populations' spawners (natural-origin and hatchery-production combined, data accessed on June 30, 2020 from WDFW Steelhead - General Information Page; Table 4). Natural-origin juvenile PS steelhead abundance estimates are calculated from the escapement data (Table 4). For this species the fecundity estimates range from 3,500 to 12,000; and the male to female ratio averages 1:1 (Pauley et al. 1986). By applying a conservative fecundity estimate of 3,500 eggs to the expected escapement of females (9,728 females), 34.05 million eggs are expected to be produced annually. With an estimated survival rate of 6.5% (Ward and Slaney 1993), the DPS should produce roughly 2.21 million natural-origin outmigrants annually.

Table 4. Expected annual abundances of PS steelhead spawners and juvenile outmigrants (WDFW 2020, data accessed on June 30, 2020 from WDFW Steelhead - General Information Page).

Life Stage	Origin	Abundance
Adult	Listed Hatchery and Natural Origin	19,456
Juvenile	Natural[1]	2,210,140
	Listed Hatchery Intact Adipose	112,500
	Listed Hatchery Adipose Clip	110,000

[1]Expected number of outmigrants=Total spawners*50% proportion of females (Pauley et al. 1986)*3,500 eggs per female (Pauley et al. 1986)*6.5% survival rate from egg to outmigrant (Ward and Slaney 1993).

2.2.1.3 Upper Columbia River Steelhead

Listed Hatchery Juvenile Releases and Natural Juvenile Abundance – Six artificial propagation programs were listed as part of the DPS (79 FR 20802). Five-year geometric means for releases from these hatchery programs are used to estimate UCR steelhead abundances (Zabel 2015, 2017a, 2017b, 2018, 2020; Table 5). To estimate abundance of natural juvenile UCR steelhead, we calculate the geometric means for outmigrating smolts over the past five years (2015-2019) by using annual abundance estimates provided by the NWFSC (Zabel 2015, 2017a, 2017b, 2018, 2020).

Adult Abundance – To calculate the abundance figures for adult spawners (natural and hatchery), we calculate the geometric means of the last five years of adult returns as measured by dam counts (Table 5). This is part of the tracking done for the Federal Columbia River Power System's Adaptive Management and Implementation Plan (AMIP 2020). The AMIP figures represent natural returns only. We calculate the hatchery returns by taking the wild return numbers and expanding them by the fractions of the wild vs. hatchery constituents found in the NWFSC outmigration estimate memos (above).

Table 5. Expected annual abundances of UCR steelhead spawners and juvenile outmigrants (AMIP 2020, Zabel 2015, 2017a, 2017b, 2018, 2020).

Life Stage	Origin	Abundance
Adult	Natural	1,931
	Listed Hatchery Intact Adipose	1,163
	Listed Hatchery Adipose Clip	5,309
Juvenile	Natural	199,380
	Listed Hatchery Intact Adipose	138,601
	Listed Hatchery Adipose Clip	687,567

2.2.1.4 Middle Columbia River Steelhead

Listed Hatchery Juvenile Releases and Natural Juvenile Abundance – Seven artificial propagation programs were listed as part of the DPS (79 FR 20802). Hatchery release estimates are used to calculate 5-year geometric means for annual LHIA and LHAC MCR steelhead abundance (Zabel 2015, 2017a, 2017b, 2018, 2020; Table 6). To estimate abundance of natural juvenile MCR steelhead, we calculate the geometric means for outmigrating smolts over the past five years (2015-2019) by using annual abundance estimates provided by the NWFSC (Zabel 2015, 2017a, 2017b, 2018, 2020).

Adult Abundance – To calculate the abundance figures for adult spawners (natural and hatchery, Table 6), we calculate the geometric means of the last five years of adult returns as measured by dam counts. This is part of the tracking done for the Federal Columbia River Power System's Adaptive Management and Implementation Plan (AMIP 2020). The AMIP figures represent natural returns only. We calculate the hatchery returns by taking the wild return numbers and expanding them by the fractions of the wild vs. hatchery constituents found in the NWFSC outmigration estimate memos (above).

Table 6. Expected annual abundances of MCR steelhead spawners and juvenile outmigrants (AMIP 2020, Zabel 2015, 2017a, 2017b, 2018, 2020).

Life Stage	Origin	Abundance
Adult	Natural	5,052
	Listed Hatchery Intact Adipose	112
	Listed Hatchery Adipose Clip	448
Juvenile	Natural	407,697
	Listed Hatchery Intact Adipose	110,469
	Listed Hatchery Adipose Clip	444,973

2.2.1.5 Lower Columbia River Chinook Salmon

Listed Hatchery Juvenile Releases and Natural Juvenile Abundance – This ESU includes fifteen ESA-listed artificial propagation programs (79 FR 20802). Hatchery release estimates are used to calculate 5-year geometric means for annual LHIA and LHAC juvenile LCR Chinook salmon abundance (Zabel 2015, 2017a, 2017b, 2018, 2020; Table 7). To estimate abundance of natural-origin juvenile LCR Chinook salmon, we calculate the geometric mean for outmigrating smolts over the past five years (2015-2019) by using annual abundance estimates provided by the NWFSC (Zabel 2014, 2015, 2017a, 2017b, 2018, 2020, Table 7).

Adult Abundance – To calculate estimates of annual abundance for adult spawners (natural- and hatchery-origin) we calculate the geometric means of the last five years of adult returns as estimated by state agencies from spawning ground surveys, counts at established fish passage monitoring locations, and other routine monitoring (ODFW Corvallis Research Laboratory - Oregon Adult Salmonid Inventory & Sampling Project; WDFW Chinook - General Information Page). The average abundance for LCR Chinook salmon populations is 68,063 adult spawners (Table 7).

Table 7. Expected annual abundances of LCR Chinook salmon spawners and juvenile outmigrants (ODFW Corvallis Research Laboratory - Oregon Adult Salmonid Inventory & Sampling Project; WDFW Chinook - General Information Page, Zabel 2015, 2017a, 2017b, 2018, 2020).

Life Stage	Origin	Abundance
Adult	Natural	29,469
	Listed Hatchery, Clipped and Intact	38,594
Juvenile	Natural	11,745,027
	Listed Hatchery Intact Adipose	962,458
	Listed Hatchery Adipose Clip	31,353,395

2.2.1.6 Lower Columbia River Coho Salmon

Listed Hatchery Juvenile Releases and Natural Juvenile Abundance – The LCR coho salmon ESU includes 21 artificial propagation programs (79 FR 20802). Hatchery release estimates are used to calculate 5-year geometric means for annual LHIA and LHAC juvenile LCR coho salmon abundance (Zabel 2015, 2017a, 2017b, 2018, 2020; Table 8). To estimate abundance of natural-origin juvenile LCR coho salmon, we calculate the geometric mean for outmigrating smolts over the past five years (2015-2019) by using annual abundance estimates provided by the NWFSC (Zabel 2015, 2017a, 2017b, 2018, 2020, Table 8).

Adult Abundance – To estimate annual abundance for adult spawners (natural- and hatchery-origin) we calculate the geometric means of the last five years of adult returns as estimated by state agencies from spawning ground surveys, counts at established fish passage monitoring locations, and other routine monitoring (Lewis et al. 2009, 2010, 2011, 2012, 2014; Sounhein et al. 2014, 2015, 2016, 2017, 2018; WDFW Conservation - Coho salmon webpage). The average abundance for LCR coho salmon populations is 38,657 adult spawners (Table 8).

Table 8. Expected annual abundances of LCR coho salmon spawners and juvenile outmigrants (Lewis et al. 2009, 2010, 2011, 2012, 2014; Sounhein et al. 2014, 2015, 2016, 2017, 2018; WDFW Conservation - Coho salmon webpage, Zabel 2015, 2017a, 2017b, 2018, 2020).

Life Stage	Origin	Abundance
Adult	Natural	29,866
	Listed Hatchery, Clipped and Intact	8,791
Juvenile	Natural	661,468

	Listed Hatchery Intact Adipose	249,784
	Listed Hatchery Adipose Clip	7,287,647

2.2.1.7 Lower Columbia River Steelhead

Listed Hatchery Juvenile Releases and Natural Juvenile Abundance – Seven artificial propagation programs were listed as part of this DPS (79 FR 20802). Hatchery release estimates are used to calculate 5-year geometric means for annual LHIA and LHAC juvenile LCR steelhead abundance (Zabel 2015, 2017a, 2017b, 2018, 2020; Table 9). To estimate abundance of juvenile natural-origin LCR steelhead, we calculate the geometric mean for outmigrating smolts over the past five years (2015-2019) by using annual abundance estimates provided by the NWFSC (Zabel 2015, 2017a, 2017b, 2018, 2020; Table 9).

Adult Abundance – To estimate annual abundance for adult spawners (natural- and hatchery-origin) we calculate the geometric means of the last five years of adult returns as estimated by state agencies from spawning ground surveys, counts at established fish passage monitoring locations, and other routine monitoring (ODFW Corvallis Research Laboratory - Oregon Adult Salmonid Inventory & Sampling Project; WDFW Chinook - General Information Page). The average abundance for LCR steelhead salmon populations is 35,217 adult spawners (Table 9).

Table 9. Expected annual abundances of LCR steelhead spawners and juvenile outmigrants (ODFW Corvallis Research Laboratory - Oregon Adult Salmonid Inventory & Sampling Project; WDFW Chinook - General Information Page; Zabel 2015, 2017a, 2017b, 2018, 2020).

Life Stage	Origin	Abundance
Adult	Natural	12,920
	Listed Hatchery, Clipped and Intact	22,297
Juvenile	Natural	352,146
	Listed Hatchery Intact Adipose	9,138
	Listed Hatchery Adipose Clip	1,197,156

2.2.1.8 Columbia River Chum Salmon

Listed Hatchery Juvenile Releases and Natural Juvenile Abundance – Two artificial propagation programs were listed as part of the ESU (79 FR 20802). All the fish produced in these hatcheries have intact adipose fins. Hatchery release estimates are used to calculate 5-year geometric means for annual hatchery-origin juvenile CR chum salmon abundance (Zabel 2015, 2017a, 2017b, 2018, 2020; Table 10). To estimate abundance of natural-origin juvenile CR chum salmon, we calculate the geometric mean for outmigrating smolts over the past five years (2015-2019) by using annual abundance estimates provided by the NWFSC (Zabel 2015, 2017a, 2017b, 2018, 2020).

Adult Abundance – To estimate annual abundance for adult spawners (natural- and hatchery-origin) we calculate the geometric means of the last five years of adult returns as estimated by state agencies from spawning ground surveys, counts at established fish passage monitoring locations, and other routine monitoring (ODFW Corvallis Research Laboratory - Oregon Adult Salmonid Inventory & Sampling Project; WDFW Chinook - General Information Page). The average abundance for CR chum salmon populations is 11,070 adult spawners (Table 10).

Table 10. Expected annual abundances of CR chum salmon spawners and juvenile outmigrants (ODFW Corvallis Research Laboratory - Oregon Adult Salmonid Inventory & Sampling Project; WDFW Chinook - General Information Page; Zabel 2015, 2017a, 2017b, 2018, 2020).

Life Stage	Origin	Abundance
Adult	Natural	10,644
	Listed Hatchery Intact Adipose	426
Juvenile	Natural	6,626,218
	Listed Hatchery Intact Adipose	601,503

2.2.1.9 Upper Willamette River Chinook Salmon

Listed Hatchery Juvenile Releases – This ESU includes spring-run Chinook salmon from six artificial propagation programs (79 FR 20802). To estimate abundance of juvenile UWR Chinook salmon, we calculate the geometric mean for outmigrating smolts over the past five years (2015-2019) by using annual abundance estimates provided by the NWFSC (Zabel 2014, 2015, 2017a, 2017b, 2018; Table 11).

Adult spawners and expected outmigration – To estimate annual abundance for adult spawners (natural- and hatchery-origin) we calculate the geometric means of five years of adult returns (2013-2017) as estimated from Willamette Falls fish counts and Clackamas River post-fishery escapement counts (ODFW - Lower Willamette Fisheries and Willamette Falls Fish Counts). The total abundance of UWR Chinook salmon is estimated at 41,679 adult spawners (Table 11).

Table 11. Expected annual abundances of UWR Chinook salmon spawners and juvenile outmigrants (ODFW - Lower Willamette Fisheries and Willamette Falls Fish Counts, Zabel 2015, 2017a, 2017b, 2018, 2020).

Life Stage	Origin	Abundance
Adult	Natural	10,203
	Listed Hatchery, Clipped and Intact	31,476
Juvenile	Natural	1,211,863
	Listed Hatchery Intact Adipose	4,214
	Listed Hatchery Adipose Clip	4,709,045

2.2.1.10 Upper Willamette River Steelhead

Listed Hatchery Juvenile Releases – There are no listed hatchery programs for this DPS. To estimate abundance of natural juvenile UWR steelhead, we calculate the geometric mean for outmigrating smolts over the past five years (2015-2019) by using annual abundance estimates provided by the NWFSC (Zabel 2015, 2017a, 2017b, 2018, 2020; Table 12).

Adult Abundance – To estimate annual abundance for adult spawners (natural- and hatchery-origin) we calculate the geometric means of five years of adult returns (2013/2014 through 2017/2018) as estimated from Willamette Falls fish counts and Clackamas River post-fishery escapement counts (ODFW - Lower Willamette Fisheries and Willamette Falls Fish Counts; Table 12).

Table 12. Expected annual abundances of UWR steelhead spawners and juvenile outmigrants (ODFW - Lower Willamette Fisheries and Willamette Falls Fish Counts, Zabel 2015, 2017a, 2017b, 2018, 2020).

Life Stage	Origin	Abundance
Adult	Natural	2,912
Juvenile	Natural	140,396

2.2.1.11 Southern Oregon/Northern California Coast Coho Salmon

Listed Hatchery Juvenile Releases – Three artificial propagation programs were listed as part of the ESU (79 FR 20802). Average hatchery release estimates are used to calculate means for annual hatchery-origin juvenile SONCC coho salmon abundance (ODFW 2011, CHSRG 2012).

Adult spawners and expected outmigration – Abundances of hatchery and natural-origin adult SONCC coho salmon spawners are estimated by summing the most recent three-year average counts from the Rogue, Trinity, and Klamath Rivers (ODFW Corvallis Research Laboratory - Oregon Adult Salmonid Inventory & Sampling Project, Kier et al 2015, CDFW 2012; Table 13). In the Shasta River (a tributary to the Klamath River) the proportion of hatchery adults is unknown, but assumed to be low. Annual returns in the Salmon River (also a Klamath River tributary) are assumed to be 50 a year, but are likely less (NMFS 2014b).

While we currently lack data on naturally-produced juvenile SONCC coho salmon production, it is possible to make rough estimates of juvenile abundance from adult return data. Quinn (2005) published estimates for salmonids in which average fecundity for coho salmon is 2,878 eggs per female. By applying the average fecundity of 2,878 eggs per female to the estimated 9,995 females returning (half of the average total number of spawners), approximately 28.8 million eggs may be expected to be produced annually. Nickelson (1998) found survival of coho salmon from egg to parr in Oregon coastal streams to be around seven percent. Thus, we approximate that this ESU produces about 2,013,593 juvenile SONCC coho salmon outmigrants annually (Table 13).

Table 13. Expected annual abundances of SONCC coho salmon spawners and juvenile outmigrants (ODFW Corvallis Research Laboratory - Oregon Adult Salmonid Inventory & Sampling Project, Kier et al 2015, CDFW 2012).

Life Stage	Origin	Abundance
Adult	Natural	9,065
	Listed Hatchery, Clipped and Intact	10,934
Juvenile	Natural	2,013,593
	Listed Hatchery Intact Adipose	575,000
	Listed Hatchery Adipose Clip	200,000

2.2.1.12 Northern California Steelhead

Adult spawners and expected outmigration – Abundances of adult NC steelhead are estimated by summing the geometric means of population spawner counts available from recent years of surveys (Gallagher and Wright 2009, 2011, and 2012; Gallagher et al. 2013, Mattole Salmon Group 2011, Duffy 2011, Counts at Van Arsdale Fisheries Station 2015, Harris and Thompson 2014, De Haven 2010, Metheny and Duffy 2014, Ricker et al. 2014, additional unpublished data provided by the NMFS SWFSC; Table 14).

Both adult and juvenile abundance data are limited for this DPS. While we currently lack data on naturally produced juvenile NC steelhead, it is possible to make rough estimates of juvenile abundance from the available adult return data. Juvenile NC steelhead abundance estimates come from the escapement data (Table 14). For the species, fecundity estimates range from 3,500 to 12,000; and the male to female ratio averages 1:1 (Pauley et al. 1986). By applying a conservative fecundity estimate of 3,500 eggs to the expected escapement of females (half of the escapement of spawners – 3,610 females), 12.6 million eggs are expected to be produced annually. With an estimated survival rate of six and a half percent (Ward and Slaney 1993), the DPS should produce roughly 821,389 natural outmigrants annually. There are not currently hatchery NC steelhead included in this DPS.

Table 14. Expected annual abundances of NC steelhead spawners and juvenile outmigrants (Gallagher and Wright 2009, 2011, and 2012; Gallagher et al. 2013, Mattole Salmon Group 2011, Duffy 2011, Counts at Van Arsdale Fisheries Station, Harris and Thompson 2014, De Haven 2010, Metheny and Duffy 2014, Ricker et al. 2014, additional unpublished data provided by the NMFS SWFSC).

Life Stage	Origin	Abundance
Adult	Natural	7,221

Juvenile	Natural	821,389

2.2.1.13 California Coastal Chinook Salmon

Adult spawners and expected outmigration – Although there are limited population-level estimates of abundance for CC Chinook salmon populations, the ESU abundance estimate is calculated by summing the average population abundances calculated from information available for the major watersheds in the ESU (Metheny and Duffy 2014, PFMC 2013, Ricker et al. 2014, Mattole Salmon Group 2011, Potter Valley Irrigation District Van Arsdale Fish Counts 2015, Sonoma Water - Chinook Salmon in the Russian River webpage; Table 15).

While we currently lack data on naturally produced juvenile CC Chinook salmon production, it is possible to make rough estimates of juvenile abundance from adult return data. Juvenile CC Chinook salmon population abundance estimates come from escapement data, the percentage of females in the population, and fecundity. Average fecundity for female CC Chinook salmon is not available. However, Healey and Heard (1984) indicates that average fecundity for Chinook salmon in the nearby Klamath River is 3,634 eggs for female. By applying an average fecundity of 3,634 eggs per female to the estimated 3,517 females returning (half of the average total number of spawners), and applying an estimated survival rate from egg to smolt of 10%, the ESU could produce roughly 1,278,078 natural outmigrants annually. There are currently no listed hatchery programs included in this ESU.

Table 15. Expected annual abundances of CC Chinook salmon spawners and juvenile outmigrants (Metheny and Duffy 2014, PFMC 2013, Ricker et al. 2014, Mattole Salmon Group 2011, Potter Valley Irrigation District - Van Arsdale Fish Counts webpage, Sonoma Water - Chinook Salmon in the Russian River webpage).

Life Stage	Origin	Abundance
Adult	Natural	7,034
Juvenile	Natural	1,278,078

2.2.1.14 Sacramento River Winter-run Chinook Salmon

Listed Hatchery Juvenile Releases – Only one artificial propagation program is considered to be part of the SacR WR Chinook salmon ESU (79 FR 20802) – the Livingston Stone National Fish Hatchery. Annual releases from the hatchery are limited to 200,000 juvenile SacR WR Chinook salmon (all adipose-clipped).

Adult spawners and expected outmigration – To estimate annual abundance for adult spawners (natural- and hatchery-origin) we calculate the average of five years of adult spawner counts (2013 through 2017) from surveys conducted by the California Department of Fish and Wildlife (CDFW

2018). The average total abundance (2013-2017) for SacR WR Chinook salmon is 2,442 adult spawners (Table 15).

Juvenile SacR WR Chinook salmon abundance estimates come from escapement data, the percentage of females in the population, and fecundity. Fecundity estimates for the ESU range from 2,000 to 5,500 eggs per female, and the proportion of female spawners in most populations is approximately 40% of escapement. By applying a conservative fecundity estimate (2,000 eggs/female) to the expected female escapement (both natural-origin and hatchery-origin spawners – 977 females), the ESU is estimated to produce approximately 1.95 million eggs annually. The average survival rate in these studies was 10%, which corresponds with those reported by Healey (1991). With an estimated survival rate of 10%, the ESU should produce roughly 195,354 natural outmigrants annually (Table 15).

Table 15. Expected annual abundances of SacR WR Chinook salmon spawners and juvenile outmigrants (CDFW 2018).

Life Stage	Origin	Abundance
Adult	Natural	210
	Listed Hatchery Adipose Clip	2,232
Juvenile	Natural	195,354
	Listed Hatchery Adipose Clip	200,000

2.2.1.15 Central Valley Spring-run Chinook Salmon

Listed Hatchery Juvenile Releases – The Feather River Hatchery is the only ESA-listed hatchery for the CVS Chinook salmon (79 FR 20802). From 1999-2009, the hatchery has released, on average, 2,169,329 CVS Chinook salmon smolts (all adipose-clipped) (California HSRG 2012).

Adult spawners and expected outmigration – To estimate annual abundance for adult spawners (natural- and hatchery-origin) we sum the five-year geometric means of adult spawner counts (2013 through 2017) from all populations with available survey data (CDFW 2018; Table 16). Historic spawning habitat on the Feather River is blocked by Oroville Dam, so all CVS Chinook salmon are returned to the hatchery (i.e., there is no naturally produced component of this population; Williams et al. 2016; CDFW 2018).

The California Department of Fish and Game (1998; now CDFW) published estimates in which average fecundity of spring-run Chinook salmon is 4,161 eggs per female. By applying the average fecundity of 4,161 eggs per female to the estimated 1,862 females returning (half of the most recent five-year average of spawners), and applying an estimated survival rate from egg to smolt of 10%, the Sacramento River basin portion of the ESU could produce roughly 775 thousand natural outmigrants annually.

Table 16. Expected annual abundances of CVS Chinook salmon spawners and juvenile outmigrants (CDFW 2018).

Life Stage	Origin	Abundance
Adult	Natural	3,727
	Listed Hatchery Adipose Clip	2,273
Juvenile	Natural	775,474
	Listed Hatchery Adipose Clip	2,169,329

2.2.1.16 California Central Valley Steelhead

Listed Hatchery Juvenile Releases – Four artificial propagation programs were listed as part of the DPS (79 FR 20802). The sum of expected annual releases from all programs is used to estimate the abundance of hatchery-origin outmigrating juvenile CCV steelhead (California HSRG 2012; Table 17).

Adult spawners and expected outmigration – To estimate annual abundance for adult spawners (natural- and hatchery-origin) we sum the geometric means of recent years of adult spawner counts from populations with available survey data (CHSRG 2012, Hannon and Deason 2005, Teubert et al. 2011, additional unpublished data provided by the NMFS SWFSC; Table 17).

Both adult and juvenile abundance data are limited for this DPS. While we currently lack data on naturally produced juvenile CCV steelhead, it is possible to make rough estimates of juvenile abundance from the available adult return data. Juvenile CCV steelhead abundance estimates come from the escapement data for natural-origin adults (Table 17). For the species, fecundity estimates range from 3,500 to 12,000; and the male to female ratio averages 1:1 (Pauley et al. 1986). By applying a conservative fecundity estimate of 3,500 eggs to the expected escapement of females (half of the escapement of hatchery- and natural-origin spawners – 2,771 females), 9.7 million eggs are expected to be produced annually. With an estimated survival rate of six and a half percent (Ward and Slaney 1993), the DPS should produce roughly 630,403 naturally produced outmigrants annually (Table 17).

Table 17. Expected annual abundances of CCV steelhead spawners and juvenile outmigrants (CHSRG 2012, Hannon and Deason 2005, Teubert et al. 2011, additional unpublished data provided by the NMFS SWFSC).

Life Stage	Origin	Abundance
Adult	Natural	1,686
	Listed Hatchery Adipose Clip	3,856
Juvenile	Natural	630,403

	Listed Hatchery Adipose Clip	1,600,653

2.2.1.17 Central California Coast Coho Salmon

Listed Hatchery Juvenile Releases – The CCC coho salmon ESU includes three artificial propagation programs (79 FR 20802). The sum of expected annual releases from all three programs is used to estimate the abundance of hatchery-origin outmigrating juveniles (Sea Grant California - Hatchery Releases webpage, Monterey Bay Salmon & Trout Project webpage, NOAA Fisheries - Species in the Spotlight Action Plan Implementation Highlights webpage; Table 18).

Adult spawners and expected outmigration – To estimate annual abundance for adult spawners (natural- and hatchery-origin) we sum the geometric means of recent years of adult spawner counts from populations with available survey data (Williams et al. 2016, J. Jahn, pers. comm., July 2, 2013; Table 18).

While we currently lack data on how many natural juvenile coho salmon this ESU produces, it is possible to make rough estimates of juvenile abundance from adult return data. Sandercock (1991) published fecundity estimates for several coho salmon stocks; average fecundity ranged from 1,983 to 5,000 eggs per female. By applying a very conservative value of 2,000 eggs per female to an estimated 1,129 females returning (50% of the run, including the Russian River hatchery returns which are allowed to spawn in the wild) to this ESU, one may expect approximately 2.2 million eggs to be produced annually. Nickelson (1998) found survival of coho salmon from egg to parr in Oregon coastal streams to be around seven percent. Thus, we can estimate that roughly the Central California Coast ESU produces 158,130 juvenile coho salmon annually.

Table 18. Expected annual abundances of CCC coho salmon spawners and juvenile outmigrants (Sea Grant California - Hatchery Releases webpage, Monterey Bay Salmon & Trout Project webpage, NOAA Fisheries - Species in the Spotlight Action Plan Implementation Highlights webpage; Williams et al. 2016, J. Jahn, pers. comm., July 2, 2013).

Life Stage	Origin	Abundance
Adult	Natural	1,932
	Listed Hatchery Intact Adipose	327
Juvenile	Natural	158,130
	Listed Hatchery Intact Adipose	165,880

2.2.1.18 Central California Coast Steelhead

Listed Hatchery Juvenile Releases – The CCC steelhead DPS includes four artificial propagation programs (79 FR 20802). The sum of expected annual releases from all three programs is used to estimate the abundance of hatchery-origin outmigrating juveniles (J. Jahn, pers. comm., July 2, 2013; Table 19).

Adult spawners and expected outmigration – To estimate annual abundance for adult spawners (natural- and hatchery-origin) we sum the geometric means of recent years of adult spawner counts from populations with available survey data (Ettlinger et al. 2012, Jankovitz 2013, MMWD and GANDA 2010, Manning and Martini-Lamb (ed.) 2012, DW Alley & Associates 2012, Atkinson 2010, Williams et al. 2011, Koehler and Blank 2012, additional unpublished data provided by the NMFS SWFSC 2013; Table 19).

Data for both adult and juvenile abundance are limited for this DPS. While we currently lack data on naturally-produced juvenile CCC steelhead, it is possible to make rough estimates of juvenile abundance from the available adult return data. Juvenile CCC steelhead abundance estimates come from the escapement data (Table 19). All returnees to the hatcheries do not contribute to the natural population and are not used in this calculation. For the species, fecundity estimates range from 3,500 to 12,000; and the male to female ratio averages 1:1 (Pauley et al. 1986). By applying a conservative fecundity estimate of 3,500 eggs to the expected escapement of females (half of the escapement of natural-origin spawners – 1,094 females), 3.8 million eggs are expected to be produced annually. In addition, hatchery managers could produce 648,841 listed hatchery juvenile CCC steelhead each year (Table 16). With an estimated survival rate of six and a half percent (Ward and Slaney 1993), the DPS should produce roughly 248,771 natural outmigrants annually (Table 30).

Table 19. Expected annual abundances of CCC steelhead spawners and juvenile outmigrants (Ettlinger et al. 2012, Jankovitz 2013, MMWD and GANDA 2010, Manning and Martini-Lamb (ed.) 2012, DW Alley & Associates 2012, Atkinson 2010, Williams et al. 2011, Koehler and Blank 2012, additional unpublished data provided by the NMFS SWFSC 2013; J. Jahn, pers. comm., July 2, 2013).

Life Stage	Origin	Abundance
Adult	Natural	2,187
	Listed Hatchery Adipose Clip	3,866
Juvenile	Natural	248,771
	Listed Hatchery Adipose Clip	648,891

2.2.1.19 South-Central California Coast Steelhead

Adult spawners and expected outmigration – To estimate annual abundance for adult spawners (natural- and hatchery-origin) we sum the geometric means of recent years of adult spawner counts from populations with available survey data (DW Alley & Associates 2012, Kraft et al. 2013, MPWMD fish counts and Los Padres Reservoir Fish Trap 2013, Allen and Riley 2012, Garrapata Creek Watershed Council 2006; San Luis Resource Conservation District 2012, City of San Luis Obispo 2006; Baglivio 2012; Stillwater Sciences et al. 2012; Table 20). There are no artificial propagation programs that are currently part of this DPS.

Both adult and juvenile abundance data are limited for this DPS. While we currently lack data on naturally-produced juvenile SCCC steelhead, it is possible to make rough estimates of juvenile abundance from the available adult return data. The estimated average adult run size is 695 (Table 20). Juvenile SCCC steelhead abundance estimates come from the escapement data. For the species, fecundity estimates range from 3,500 to 12,000; and the male to female ratio averages 1:1 (Pauley et al. 1986). By applying a conservative fecundity estimate of 3,500 eggs to the expected escapement of females (half of the escapement of spawners – 348 females), 1.2 million eggs are expected to be produced annually. With an estimated survival rate of six and a half percent (Ward and Slaney 1993), the DPS should produce roughly 79,057 natural outmigrants annually (Table 20).

Table 20. Expected annual abundances of SCCC steelhead spawners and juvenile outmigrants (DW Alley & Associates 2012, Kraft et al. 2013, MPWMD fish counts and Los Padres Reservoir Fish Trap 2013, Allen and Riley 2012, Garrapata Creek Watershed Council 2006; San Luis Resource Conservation District 2012, City of San Luis Obispo 2006; Baglivio 2012; Stillwater Sciences et al. 2012)

Life Stage	Origin	Abundance
Adult	Natural	695
Juvenile	Natural	79,057

2.2.1.20 Southern California Steelhead

At the time of listing, NMFS concluded that the SC steelhead DPS was in danger of extinction throughout all or a significant portion of its range, and listed it as endangered (62 FR 43937). There is no hatchery production in support of this DPS.

Very little data regarding abundances of Southern California Coast steelhead are available, but the picture emerging from available data suggest very small (<10 fish) but surprisingly consistent annual runs of anadromous fish across the diverse set of basins that are currently being monitored. It is believed that population abundance trends can significantly vary based on yearly rainfall and storm events within the range of the Southern California Coast DPS (Williams et al. 2011). Much of the data pertaining to the incidence of adult anadromous *O. mykiss* in the SC steelhead DPS is not appropriate to be used to generate abundance estimates. However, the annual presence and count of adult SC steelhead has been documented annually in a number of streams (Table 21).

Table 21. Total and mean observations of adult anadromous SC steelhead from 2005 to 2014. (Santa Ynez River Adaptive Management Committee 2009, United States Bureau of Reclamation 2011, Hovey and O'Brien 2013, Dagit et al. 2015, Casitas Municipal Water District (2005 through 2014), United Water Conservation District (2005 through 2014), Mark Capelli unpublished data, George Sutherland unpublished data, Resource Conservation

District of the Santa Monica Mountains unpublished data, Mauricio Gomez unpublished data, Dave Katjaniak unpublished data)

System	Years	Observations	
		Total	**Mean Annual**
Santa Ynez River	2005 - 2014	29	2.9
Ventua River	2006 - 2014	13	1.4
Santa Clara River	2005 - 2014	5	0.5
Goleta Slough	2005 - 2014	6	0.6
Mission Creek	2005 - 2014	18	1.8
Carpinteria Creek	2008	3	-
Conejo Creek	2013	1	-
Malibu Creek	2006 - 2014	23	2.6
Topanga Creek	2005 - 2014	8	0.8
Ballona Creek	2008	2	-
San Juan Creek	2005 - 2014	5	0.5
Santa Margarita Creek	2009	1	-
San Luis Rey River	2007	2	-
Las Penasquito Creek	2012	1	-
	Total	**117**	**11.1**

The observations of adult SC steelhead for the last ten years of only average around 11 individuals annually (Table 21). However, the most recent SC steelhead recovery plan found no evidence that the annual return of anadromous adults has changed since the original estimated number of less than 500 individuals (Busby et al. 1996, NMFS 2012d). Given this range of expected annual returning spawners, the most conservative estimate of juvenile production based on those returns would be based on the assumption that the number of returning spawners for the DPS is just 11 fish. For the species, fecundity estimates range from 3,500 to 12,000; and the male to female ratio averages 1:1 (Pauley et al. 1986). By applying a conservative fecundity estimate of 3,500 eggs to the expected escapement of females (half of the escapement of spawners – 5.5 females), 19,425 eggs would be expected to be produced annually. Assuming an estimated survival rate of six and a half percent (Ward and Slaney 1993), the DPS would produce a minimum of 1,262 natural outmigrants annually. However, further complicating this calculation, the SC steelhead DPS is also influenced by the presence of a significant unlisted resident population of *O. mykiss.* Due to the phenotypic plasticity between these two life history strategies that has been demonstrated in *O. mykiss* (Pearse 2009), it is possible that additional outmigrants may be derived from this unlisted resident population, or that some residual offspring of anadromous parents may express a resident life history. For that reason, differentiating anadromous and resident juveniles pre-smoltification is not possible, so for precautionary reasons, all juvenile *O. mykiss* that occur within the SC steelhead range are considered to be SC steelhead.

Given the lack of consistent monitoring data, low absolute numbers of observations, recognized potential for highly variable escapement from year to year, and the potential for *O. mykiss* phenotypic plasticity we do not consider these estimates suitable for estimating proportions of the DPS which may be affected by the research actions considered in this opinion. These available data are presented for context, however, only qualitative analysis of impacts of the proposed research activities will be performed for the Southern California steelhead DPS.

2.2.1.21 Southern Eulachon

For most sDPS eulachon spawning runs, abundance is unknown with the exception of the Columbia and Fraser River spawning runs. Beginning in 1995, the Canada's Department of Fisheries and Oceans (DFO) started annual surveys in the Fraser River. These surveys consisted of estimating larval density, measuring river discharge, and using estimates of relative fecundity to determine spawning biomass (Hay et al. 2002). Beginning in 2011, Oregon Department of Fish and Wildlife (ODFW) and Washington Department of Fish and Wildlife (WDFW) began instituting similar monitoring in the Columbia River. From 2015 through 2019, the eulachon spawner population estimate for the Fraser River is 2,877,962 adults and for the Columbia River 29,151,081 adults (Table 22). The combined spawner estimate from the Columbia and Fraser rivers is 32.03 million eulachon.

Table 22. sDPS eulachon spawning estimates for the lower Fraser River (British Columbia, Canada) and Columbia River (Oregon/Washington states, USA).

Year	Fraser River		Columbia River	
	Biomass estimate (metric tons)[a]	Estimated spawner population[b]	Biomass estimate (metric tons)	Estimated spawner population[c]
2015	317	7,827,292	4469	110,000,000
2016	44	1,086,438	2217	54,556,500
2017	35	864,212	744	18,307,100
2018	408	10,074,244	167	4,104,300
2019	108	2,666,712	1897	46,684,800
2015-2019[d]	**117**	**2,877,962**	**1,184**	**29,151,081**

[a] DFO 2020
[b] Estimated population numbers are calculated as 11.16 eulachon per pound.
[c] Langness et al. 2020
[d] Five-year geometric mean of mean eulachon biomass estimates (2015-2019).

2.2.1.22 Southern Green Sturgeon

Green sturgeon are composed of two DPSs with two geographically distinct spawning locations. The northern DPS spawn in rivers north of and including the Eel River in Northern California with known spawning occurring in the Eel, Klamath, and Trinity rivers in California and the Rogue and Umpqua rivers in Oregon. The sDPS spawn in rivers south of the Eel River which is now restricted to the Sacramento River. Since 2010, Dual Frequency Identification Sonar (DIDSON) surveys of aggregating sites in the upper Sacramento River for sDPS green sturgeon have been conducted. Annually, green sturgeon adults were monitored with tagged individuals showing a mean spawning periodicity was 3.69 years (Mora et al. 2018). Results from these surveys for sDPS green sturgeon resulted in an estimate of 4,387 juveniles (freshwater stage, less than 60 cm length, and one to three years of age), 11,055 sub-adults (3-20 years and 60-165 cm length), and 2,106 adults (greater than 165 cm in length and older than 20 years) (Table 23; Mora et al. 2018).

Table 23. Six-year geometric mean (2010-2015) abundance estimate of sDPS green sturgeon (Mora et al. 2018).

		95% Confidence Interval	
Life stage	**Estimate**	**Low**	**High**
Juvenile	4,387	2,595	6,179
Sub-adult	11,055	6,540	15,571
Adult	2,106	1,246	2,966
ESU abundance[a]	**17,548**	**12,614**	**22,482**

2.2.2 Status of the Species' Critical Habitat

This section describes the status of designated critical habitat affected by the proposed action by examining the condition and trends of the essential physical and biological features of that habitat throughout the designated areas. These features are essential to the conservation of the ESA-listed species because they support one or more of the species' life stages (*e.g.*, sites with conditions that support spawning, rearing, migration and foraging).

For most salmon and steelhead, NMFS's critical habitat analytical review teams (CHARTs) ranked watersheds within designated critical habitat at the scale of the fifth-field hydrologic unit code (HUC5) in terms of the conservation value they provide to each ESA-listed species that they support (NMFS 2005). The conservation rankings were high, medium, or low. To determine the conservation value of each watershed to species viability, the CHARTs evaluated the quantity and quality of habitat features, the relationship of the area compared to other areas within the species' range, and the significance to the species of the population occupying that area. Even if a location had poor habitat quality, it could be ranked with a high conservation value if it were essential due to factors such as limited availability, a unique contribution of the population it served, or is serving another important role.

A summary of the status of critical habitats, considered in this opinion, is provided in Table 24, below.

Table 24. Critical habitat, designation date, federal register citation, and status summary for critical habitat considered in this opinion.

Species	Designation Date and Federal Register Citation	Critical Habitat Status Summary
Puget Sound Chinook salmon	09/02/2005 70 FR 52630	Critical habitat for Puget Sound Chinook salmon includes 1,683 miles of streams, 41 square mile of lakes, and 2,182 miles of nearshore marine habitat in Puget Sounds. The Puget Sound Chinook salmon ESU has 61 freshwater and 19 marine areas within its range. Of the freshwater watersheds, 41 are rated high conservation value, 12 low conservation value, and eight received a medium rating. Of the marine areas, all 19 are ranked with high conservation value. Primary constitute elements relevant for this consultation include: 1) Estuarine areas free of obstruction with water quality and aquatic vegetation to support juvenile transition and rearing; 2) Nearshore marine areas free of obstruction with water quality conditions, forage, submerged and overhanging large wood, and aquatic vegetation to support growth and maturation; 3) Offshore marine areas with water quality conditions and forage, including aquatic invertebrates and fishes, supporting growth and maturation.
Puget Sound steelhead	02/24/2016 81 FR 9252	Critical habitat for Puget Sound steelhead includes 2,031 stream miles. Nearshore and offshore marine waters were not designated for this species. There are 66 watersheds within the range of this DPS. Nine watersheds received a low conservation value rating, 16 received a medium rating, and 41 received a high rating to the DPS.
Upper Columbia River steelhead	09/02/2005 70 FR 52630	Critical habitat encompasses 10 subbasins in Washington containing 31 occupied watersheds, as well as the Columbia River rearing/migration corridor. Most HUC5 watersheds with PBFs for salmon are in fair-to-poor or fair-to-good condition (NMFS 2005). However, most of these watersheds have some or a high potential for improvement. We rated conservation value of HUC5 watersheds as high for 20 watersheds, medium for eight watersheds, and low for three watersheds.
Middle Columbia River steelhead	09/02/2005 70 FR 52630	Critical habitat encompasses 15 subbasins in Oregon and Washington containing 111 occupied watersheds, as well as the Columbia River rearing/migration corridor. Most HUC5 watersheds with PBFs for salmon are in fair-to-poor or fair-to-good condition (NMFS 2005). However, most of these watersheds have some or a high potential for improvement. We rated conservation value of occupied HUC5 watersheds as high for 80 watersheds, medium for 24 watersheds, and low for 9 watersheds.
Lower Columbia River Chinook salmon	09/02/2005 70 FR 52630	Critical habitat encompasses 10 subbasins in Oregon and Washington containing 47 occupied watersheds, as well as the lower Columbia River rearing/migration corridor. Most HUC5 watersheds with PBFs for salmon are in fair-to-poor or fair-to-good condition (NMFS 2005). However, most of these watersheds have some, or high potential for improvement. We rated conservation value of HUC5 watersheds as high for 30 watersheds, medium for 13 watersheds, and low for four watersheds.
Lower Columbia River coho salmon	02/24/2016 81 FR 9252	Critical habitat encompasses 10 subbasins in Oregon and Washington containing 55 occupied watersheds, as well as the lower Columbia River and estuary rearing/migration corridor. Most HUC5 watersheds with PBFs for salmon are in fair-to-poor or fair-to-good condition (NMFS 2005). However, most of these watersheds have some or a high potential for improvement. We rated conservation value of HUC5 watersheds as high for 34 watersheds, medium for 18 watersheds, and low for three watersheds.
Lower Columbia River steelhead	09/02/2005 70 FR 52630	Critical habitat encompasses nine subbasins in Oregon and Washington containing 41 occupied watersheds, as well as the lower Columbia River rearing/migration corridor. Most HUC5 watersheds with PBFs for salmon are in fair-to-poor or fair-to-good condition (NMFS 2005). However, most of these watersheds have some or a high potential for improvement. We rated conservation value of HUC5 watersheds as high for 28 watersheds, medium for 11 watersheds, and low for two watersheds.

Species	Designation Date and Federal Register Citation	Critical Habitat Status Summary
Columbia River chum salmon	09/02/2005 70 FR 52630	Critical habitat encompasses six subbasins in Oregon and Washington containing 19 occupied watersheds, as well as the lower Columbia River rearing/migration corridor. Most HUC5 watersheds with PBFs for salmon are in fair-to-poor or fair-to-good condition (NMFS 2005). However, most of these watersheds have some or a high potential for improvement. We rated conservation value of HUC5 watersheds as high for 16 watersheds, and medium for three watersheds.
Upper Willamette River Chinook salmon	09/02/2005 70 FR 52630	Critical habitat encompasses 10 subbasins in Oregon containing 56 occupied watersheds, as well as the lower Willamette/Columbia River rearing/migration corridor. Most HUC5 watersheds with PBFs for salmon are in fair-to-poor or fair-to-good condition. However, most of these watersheds have some, or high, potential for improvement. Watersheds are in good to excellent condition with no potential for improvement only in the upper McKenzie River and its tributaries (NMFS 2005). We rated conservation value of HUC5 watersheds as high for 22 watersheds, medium for 16 watersheds, and low for 18 watersheds.
Upper Willamette River steelhead	09/02/2005 70 FR 52630	Critical habitat encompasses seven subbasins in Oregon containing 34 occupied watersheds, as well as the lower Willamette/Columbia River rearing/migration corridor. Most HUC5 watersheds with PBFs for salmon are in fair-to-poor or fair-to-good condition (NMFS 2005). However, most of these watersheds have some or a high potential for improvement. Watersheds are in good to excellent condition with no potential for improvement only in the upper McKenzie River and its tributaries (NMFS 2005). We rated conservation value of HUC5 watersheds as high for 25 watersheds, medium for 6 watersheds, and low for 3 watersheds.
Southern Oregon/Northern California Coast coho salmon	05/05/1999 64 FR 24049	Critical habitat includes all areas accessible to any life-stage up to long-standing, natural barriers and adjacent riparian zones. SONCC coho salmon critical habitat within this geographic area has been degraded from historical conditions by ongoing land management activities. Habitat impairments recognized as factors leading to decline of the species that were included in the original listing notice for SONCC coho salmon include: 1) Channel morphology changes; 2) substrate changes; 3) loss of in-stream roughness; 4) loss of estuarine habitat; 5) loss of wetlands; 6) loss/degradation of riparian areas; 7) declines in water quality; 8) altered stream flows; 9) fish passage impediments; and 10) elimination of habitat
Northern California steelhead	9/2/2005 70 FR 52488	There are approximately 3,028 miles of stream habitats and 25 square miles of estuary habitats designated as critical habitat for NC steelhead. NMFS determined that marine areas did not warrant consideration as critical habitat for this DPS. NC steelhead PBFs are sites and habitat components which support one or more life stages. There are 50 watersheds within the range of this DPS. Nine watersheds received a low rating, 14 received a medium rating, and 27 received a high rating of conservation value to the DPS. Two estuarine habitats, Humboldt Bay and the Eel River estuary, have high conservation value ratings. Since designation, critical habitat for this species has continued to be degraded somewhat by the factors listed above in the status section. Nonetheless, a number of restoration efforts have been undertaken by local, state, and Federal entities resulting in slightly improved conditions in some areas and a slowing of the negative trend.
California Coastal Chinook salmon	09/02/2005 70 FR 52488	Critical habitat includes approximately 1,475 miles of stream habitats and 25 square miles of estuary habitats. There are 45 watersheds within the range of this ESU. Eight watersheds received a low rating, 10 received a medium rating, and 27 received a high rating of conservation value to the ESU. Two estuarine habitat areas used for rearing and migration (Humboldt Bay and the Eel River Estuary) also received a high conservation value rating. PBFs include freshwater spawning sites, freshwater rearing sites, freshwater migration corridors, and nearshore marine areas. Since designation, critical habitat for this species has continued to be.

Species	Designation Date and Federal Register Citation	Critical Habitat Status Summary
		Nonetheless, a number of restoration efforts have been undertaken by local, state, and Federal entities resulting in slightly improved conditions in some areas and a slowing of the negative trend.
Sacramento River winter-run Chinook salmon	06/16/1993 58 FR 33212 Modified 03/23/1999 64 FR 14067	Critical habitat includes the following waterways, bottom and water of the waterways and adjacent riparian zones: The Sacramento River from Keswick Dam, Shasta County (RK 486) to Chipps Island (RK 0) at the westward margin of the Sacramento-San Joaquin Delta, all waters from Chipps Island westward to Carquinez Bridge, including Honker Bay, Grizzly Bay, Suisun Bay, and Carquinez Strait, all waters of San Pablo Bay westward of the Carquinez Bridge, and all waters of San Francisco Bay (north of the San Francisco/Oakland Bay Bridge) from San Pablo Bay to the Golden Gate Bridge. The critical habitat for this species was designated before the CHART team process, thus watersheds have not yet been evaluated for conservation value. Since designation, critical habitat for this species has continued to be degraded. Nonetheless, a number of restoration efforts have been undertaken by local, state, and Federal entities resulting in slightly improved conditions in some areas and a slowing of the negative trend.
Central Valley spring-run Chinook salmon	09/02/2005 70 FR 52488	Critical habitat includes approximately 1,373 miles of stream habitats and 427 square miles of estuary habitats in 37 watersheds. The CHART rated seven watersheds as having low, three as having medium, and 27 as having high conservation value to the ESU. Four of these watersheds comprise portions of the San Francisco-San Pablo-Suisun Bay estuarine complex, which provides rearing and migratory habitat for the ESU. PBFs include freshwater spawning sites, freshwater rearing sites, and freshwater migration corridors. Since designation, critical habitat for this species has continued to be degraded somewhat by the factors listed above in the status section. Nonetheless, a number of restoration efforts have been undertaken by local, state, and Federal entities resulting in slightly improved conditions in some areas and a slowing of the negative trend.
California Central Valley steelhead	9/2/2005 70 FR 52488	There are approximately 2,308 miles of stream habitats and 254 square miles of estuary habitats designated as critical habitat for CCV steelhead. NMFS determined that marine areas did not warrant consideration as critical habitat for this DPS. CCV steelhead PBFs are those sites and habitat components which support one or more life stages. There are 67 watersheds within the range of this DPS. Twelve watersheds received a low rating, 18 received a medium rating, and 37 received a high rating of conservation value to the DPS. Since designation, critical habitat for this species has continued to be degraded somewhat by the factors listed above in the status section. Nonetheless, a number of restoration efforts have been undertaken by local, state, and Federal entities resulting in slightly improved conditions in some areas and a slowing of the negative trend.
Central California Coast coho salmon	05/05/1999 64 FR 24049	Critical habitat encompasses accessible reaches of all rivers (including estuarine areas and tributaries) between Punta Gorda and the San Lorenzo River (inclusive) in California, including two streams entering San Francisco Bay: Arroyo Corte Madera Del Presidio and Corte Madera Creek. Critical habitat includes all waterways, substrate, and adjacent riparian zones below longstanding, naturally impassable barriers (i.e., natural waterfalls in existence for at least several hundred years). NMFS has identified several dams in the CCC coho salmon critical habitat range that currently block access to habitats historically occupied by coho salmon. However, NMFS has not designated these inaccessible areas as critical habitat because the downstream areas are believed to provide sufficient habitat for conserving the ESUs. The critical habitat for this species was designated before the CHART team process, thus watersheds have not yet been evaluated for

Species	Designation Date and Federal Register Citation	Critical Habitat Status Summary
		conservation value. Since designation, critical habitat for this species has continued to be degraded. Nonetheless, a number of restoration efforts have been undertaken by local, state, and Federal entities resulting in slightly improved conditions in some areas and a slowing of the negative trend.
Central California Coast steelhead	9/2/2005 70 FR 52488	There are approximately 1,465 miles of stream habitats and 386 square miles of estuary habitats designated as critical habitat for CCC steelhead. NMFS determined that marine areas did not warrant consideration as critical habitat for this DPS. CCC steelhead PBFs are sites and habitat components which support one or more life stages including freshwater spawning sites, freshwater rearing sites, freshwater migration corridors, and nearshore marine areas. There are 46 watersheds within the range of this DPS. For conservation value to the DPS, fourteen watersheds received a low rating, 13 received a medium rating, and 19 received a high rating. Since designation, critical habitat for this species continues to be degraded by several factors listed in the status section. Nonetheless, a number of restoration efforts have been undertaken by local, state, and Federal entities to improve conditions in some areas and slow the negative trend.
South-Central California Coast steelhead	9/2/2005 70 FR 52488	There are approximately 1,249 miles of stream habitats and three square miles of estuary habitats designated as critical habitat for S-CCC steelhead. NMFS determined that marine areas did not warrant consideration as critical habitat for this DPS. S-CCC steelhead PBFs are sites and habitat components which support one or more life stages including freshwater spawning sites, freshwater rearing sites, freshwater migration corridors, and nearshore marine areas. There are 30 watersheds within the range of this DPS. For conservation value to the DPS, six watersheds received a low rating, 11 received a medium rating, and 13 received a rated high. Morro Bay, an estuarine habitat, is used as rearing and migratory habitat for spawning and rearing steelhead. S-CCC steelhead inhabit coastal river basins from the Pajaro River south to, but not including, the Santa Maria River. Major watersheds include Pajaro River, Salinas River, Carmel River, and numerous smaller rivers and streams along the Big Sur coast and southward. Only winter-run steelhead are found in this DPS. The climate is drier and warmer than in the north that is reflected in vegetation changes from coniferous forests to chaparral and coastal scrub. The mouths of many rivers and streams in this DPS are seasonally closed by sand berms that form during the low stream flows of summer. Since designation, critical habitat for this species continues to be degraded by several factors listed in the status section Nonetheless, a number of restoration efforts have been undertaken by local, state, and Federal entities to improve conditions in some areas and slow the negative trend.
Southern California steelhead	9/2/2005 70 FR 52488	Critical habitat consists of 708 miles of stream habitat from 32 watersheds, with almost all occupied habitat from southern San Luis Obispo at the Santa Maria River to northern San Diego County at the San Mateo Creek designated. Within occupied habitat, all military lands are excluded. There are also portions excluded due to economic considerations. Most watersheds south of Malibu Creek were not designated, though San Juan Creek and San Mateo Creek were designated. There are two general types of watersheds within the range of this DPS: those with short coastal streams that drain mountain ranges directly adjacent to the coast, and watersheds that contain larger river systems that continue inland through gaps in the coastal ranges. The rivers and streams in this area often have interrupted base flow patterns due to geologic formations and precipitation patterns that have strong seasonality. Extensive, high quality habitat exists above a large number of passage barriers in these river systems, but these areas are currently not included within the DPS. Little high-quality remains in the currently accessible portion of the

Species	Designation Date and Federal Register Citation	Critical Habitat Status Summary
		range; for example, the majority of estuarine habitats have been lost, only an average of 22% of these habitats remain, and those wetland areas that remain are highly degraded, with many at continued risk of loss or further degradation. The conservation value of any remaining accessible habitat is therefore very high, and restoring access to above-barrier habitats remains a recovery priority. Although numerous historically harmful practices have been halted, much of the historical damage remains to be addressed.
Southern DPS (sDPS) of eulachon	10/20/2011 76 FR 65324	Critical habitat for eulachon includes portions of 16 rivers and streams in California, Oregon, and Washington. All of these areas are designated as migration and spawning habitat for this species. In Oregon, we designated 24.2 miles of the lower Umpqua River, 12.4 miles of the lower Sandy River, and 0.2 miles of Tenmile Creek. We also designated the mainstem Columbia River from the mouth to the base of Bonneville Dam, a distance of 143.2 miles. Dams and water diversions are moderate threats to eulachon in the Columbia and Klamath rivers where hydropower generation and flood control are major activities. Degraded water quality is common in some areas occupied by southern DPS eulachon. In the Columbia and Klamath river basins, large-scale impoundment of water has increased winter water temperatures, potentially altering the water temperature during eulachon spawning periods. Numerous chemical contaminants are also present in spawning rivers, but the exact effect these compounds have on spawning and egg development is unknown. Dredging is a low to moderate threat to eulachon in the Columbia River. Dredging during eulachon spawning would be particularly detrimental.
Southern DPS (sDPS) of green sturgeon	10/09/2009 74 FR 52300	Critical habitat has been designated in coastal U.S. marine waters within 60 fathoms depth from Monterey Bay, California (including Monterey Bay), north to Cape Flattery, Washington, including the Strait of Juan de Fuca, Washington, to its United States boundary; the Sacramento River, lower Feather River, and lower Yuba River in California; the Sacramento-San Joaquin Delta and Suisun, San Pablo, and San Francisco bays in California; tidally influenced areas of the Columbia River estuary from the mouth upstream to river mile 46; and certain coastal bays and estuaries in California (Humboldt Bay), Oregon (Coos Bay, Winchester Bay, Yaquina Bay, and Nehalem Bay), and Washington (Willapa Bay and Grays Harbor), including, but not limited to, areas upstream to the head of tide in various streams that drain into the bays, as listed in Table 1 in USDC (2009). The CHART identified several activities that threaten the PBFs in coastal bays and estuaries and necessitate the need for special management considerations or protection. The application of pesticides is likely to adversely affect prey resources and water quality within the bays and estuaries, as well as the growth and reproductive health of Southern DPS green sturgeon through bioaccumulation. Other activities of concern include those that disturb bottom substrates, adversely affect prey resources, or degrade water quality through re-suspension of contaminated sediments. Of particular concern are activities that affect prey resources. Prey resources are affected by: commercial shipping and activities generating point source pollution and non-point source pollution that discharge contaminants and result in bioaccumulation of contaminants in green sturgeon; disposal of dredged materials that bury prey resources; and bottom trawl fisheries that disturb the bottom (but result in beneficial or adverse effects on prey resources for green sturgeon).
Southern resident killer whale	11/29/2006 71 FR 69054	Critical habitat consists of three specific marine areas of inland waters of Washington: 1) the Summer Core Area in Haro Strait and waters around the San Juan Islands; 2) Puget Sound; and 3) the Strait of Juan de Fuca. These areas comprise approximately 2,560 square miles of marine habitat. Based on the natural

Species	Designation Date and Federal Register Citation	Critical Habitat Status Summary
		history of the Southern Residents and their habitat needs, NMFS identified three PBFs, or physical or biological features, essential for the conservation of Southern Residents: 1) Water quality to support growth and development; 2) prey species of sufficient quantity, quality, and availability to support individual growth, reproduction and development, as well as overall population growth; and 3) passage conditions to allow for migration, resting, and foraging Water quality in Puget Sound, in general, is degraded. On September 19, 2019 NMFS proposed to revise the critical habitat designation for the SRKW DPS under the ESA by designating six new areas along the U.S. West Coast (84 FR 49214). Specific new areas proposed along the U.S. West Coast include 15,626.6 square miles (mi\2\) (40,472.7 square kilometers (km\2\)) of marine waters between the 6.1-meter (m) (20 feet (ft)) depth contour and the 200-m (656.2 ft) depth contour from the U.S. international border with Canada south to Point Sur, California. The proposed rule to revise critical habitat designation was based on new information about the SRKW's habitat use along the coast.

2.3 Action Area

"Action area" means all areas to be affected directly or indirectly by the Federal action and not merely the immediate area involved in the action (50 CFR 402.02). For the purposes of this opinion, the action area includes all river reaches accessible to listed Chinook salmon, chum salmon, coho salmon, and steelhead in all sub-basins of the Pacific Northwest (Washington and Oregon) and California. Additionally, the action area includes all marine waters off the West Coast of the contiguous United States, including nearshore waters from California to the Canadian borders and Puget Sound, accessible to listed Chinook salmon, chum salmon, coho salmon, steelhead, eulachon, and green sturgeon.

Where it is possible to narrow the range of the research, the effects analysis would take that limited geographic scope into account when determining the proposed actions' impacts on the species and their critical habitat (see permit summaries below for the instances in which this would be applicable). Still, the action area is generally spread out over much of Oregon, Washington and California. It is also discontinuous. That is, there are large areas in between the various actions' locations where listed salmonids, sturgeon, eulachon, etc., do exist, but where they would not be affected to any degree by any of the proposed activities. As noted earlier, the proposed actions could affect the Southern Resident killer whales' prey base (Chinook salmon) and those effects are described in the Not Likely to Adversely Affect section (2.11).

In most cases, the proposed research activities would take place in individually very small sites. For example, the researchers might electrofish a few hundred feet of river, deploy a beach seine covering only a few hundred square feet of stream, or operate a screw trap in a few tens of square feet of habitat. Many of the proposed research activities would take place in designated critical habitat. More detailed habitat information (i.e., migration barriers, physical and biological habitat features, and special management considerations) for species considered in this opinion may be found in the Federal Register notices designating critical habitat (Table 24).

2.3.1. Action Areas for the Individual Permits

Permit 1336-9R – The proposed activities would take place in several locations scattered throughout a great deal of Western Washington and Oregon—from the Puget Sound to the Molalla River in Oregon and all across southwest Washington. The activities would mostly take place in Mason and Lewis Counties in Washington and Clackamas and County in Oregon, but the work would move around a fair amount from year to year. Because the surveys would be conducted in response to uncertain economic drivers (timber sales and harvest), it is impossible to be more precise about where the researchers are likely to be working at any given time.

Permit 13791-7R – The proposed activities would take place in several long-term monitoring locations in the California Central Valley including the Sacramento River, San Joaquin River, San Joaquin Delta, San Pablo Bay, San Francisco Bay, Suisun Bay, San Francisco Estuary, Liberty Island Cache Slough Complex, and the Yolo Bypass.

Permit 14516-3R – The proposed activities would occur in two sets of locations; one project would take place at long-term monitoring locations in Gazos, Waddell, and Scott creek watersheds within the San Lorenzo-Soquel basin, and the other would take place within Pescadero Creek and San Gregorio lagoons within the San Francisco Coastal South basin.

Permit 14808-5R – The proposed activities would take place within the Upper and Lower Sacramento River basins on the Sacramento River, including locations from Keswick Dam (RM 302) downstream to the Red Bluff Diversion Dam (RM 243), near the town of Colusa, and downstream of Knights Landing through Clarksburg, California.

Permit 15215-2R – The proposed activities would take place throughout California in any state waters where ESA-listed fish are present and affected by a disease event.

Permit 15390-2R – The proposed activities would take place in tributaries of Santa Monica Bay, including Topanga Creek from Topanga Lagoon upstream to the town of Topanga, Malibu Creek Lagoon, Malibu and Arroyo Sequit creeks, and from the upstream end of Malibu Lagoon to Ridge Dam in southern California.

Permit 16122-3R – The proposed activities would take place at river mile 24.9 on the Okanogan River in Washington State. Two screw traps would be cabled to piling structures on the State Route 20 Bridge at that location.

Permit 16290-4R – The proposed activities would take place in at least 12 tributaries to the Willamette River in Oregon. The work could take place in mainstem and off-channel habitat as high in the basin as the McKenzie River and as low as the lower Willamette River below its confluence with the Clackamas River. Because the work would move from place to place in any given year (and between years), it is impossible to be more precise about the exact locations at any given time.

Permit 16417-3M – The proposed activities would take place at multiple locations in the Guadalupe River, Coyote Creek, and Stevens Creek Watershed (Guadalupe Creek, Alamitos Creek, Calero Creek, Los Gatos Creek, Guadalupe River, Stevens Creek, Coyote Creek, and Upper Penitencia Creek), Pajaro Watershed (Pacheco Creek, Cedar Creek, North Fork Pacheco Creek, Middle Fork Pacheco Creek, South Fork Pacheco Creek, Hagerman Canyon, Uvas Creek, LLagas Creek, Bodfish Creek, Little Arthur Creek, Tar Creek, and Solis Creek), and Lake Almaden in North Santa Clara County, California.

Permit 17063-3R – The proposed activities would take place in the Mad River (including sections of the Mad River from R.W. Mathews Dam to the estuary), Lower Eel River and Eel River drainage, Van Duzen River, and Weaver Creek drainage in the Mad-Redwood, Lower Eel, and Trinity River sub-basins of coastal Northern California.

Permit 17272-2R – The proposed activities would take place in multiple locations in the mainstem Klamath River in Northern California. The activities would be conducted at numerous sites from the Iron Gate Dam (RM 192.8) down to the Trinity River, and in the estuary at the mouth of the Klamath River from the Pacific Ocean to an area upstream of the Hwy 101 bridge.

Permit 17867-2R – The proposed activities would take place within the Lower Eel River, Van Duzen River, Freshwater Creek, Elk River, Mattole River, and Bear River and along any other fish bearing stream on HRC property within the Mad-Redwood basin, Lower Eel basin, and Mattole basin in Humboldt County, California.

Permit 18921-2R – The proposed activities would take place in the marine waters immediately adjacent to Cypress Island (of the San Juan Island archipelago) in Secret Harbor (Skagit County, WA).

Permit 18937-3R – The proposed activities would take place in multiple tributaries of the Russian River in California, including Dutch Bill, Green Valley, Mill, Porter and Willow Creek watersheds.

Permit 19121-2R – The proposed activities would take place at numerous locations throughout the north San Francisco Bay-Delta (including the general Cache Slough complex, Little Holland Tract, and the Sacramento Deep Water Shipping Channel) downstream to the upper San Francisco Estuary in the vicinity of Suisun Bay in the San Francisco Estuary and Sacramento-San Joaquin Delta, California.

Permit 23649 – The proposed activities would take place throughout a one-mile section of the Crooked River downstream from Bowman Dam in Central Oregon. A screw trap will be located as closely as possible to the Bowman Dam outlet structure, and the researchers would electrofish the one mile of river below that.

Permit 23843 – The proposed activities would take place in the Skagit River and its floodplain from the confluence of the downstream of the Baker River (River Mile 54) near Concrete, WA to the Cascade River Rd. bridge (River Mile 79) near Marblemount, WA. Within that range, is the restoration project at Barnaby Reach, which extends from the mouth of Illabot Creek downstream to the Sauk River. The fence weir smolt traps will be installed at three locations near the restoration action and at three locations outside of the restoration project zone for reference. The smolt traps would be placed in the backwaters, side channels and sloughs of the floodplain and the researchers would also conduct electrofishing, and redd- and snorkel surveys in those areas as well.

2.4 Environmental Baseline

The "environmental baseline" refers to the condition of the listed species or its designated critical habitat in the action area, without the consequences to the listed species or designated critical habitat caused by the proposed action. The environmental baseline includes the past and present impacts of all Federal, State, or private actions and other human activities in the action area, the anticipated impacts of all proposed Federal projects in the action area that have already undergone formal or early section 7 consultations, and the impact of State or private actions which are contemporaneous with the consultation in process. The consequences to listed species or designated critical habitat from ongoing agency activities or existing agency facilities that are not within the agency's discretion to modify are part of the environmental baseline (50 CFR 402.02).

The environmental baseline for this opinion is therefore the result of the impacts that many activities (summarized below and in the species' status sections) have had on the various listed species' survival and recovery. In many cases, the action area under consideration covers individual animals that could come from anywhere in the various listed species' entire ranges (see Sections 1.3 and 2.3). As a result, the effects of these past activities on the species themselves (that is, effects on abundance, productivity, etc.) cannot be tied to any particular population and are therefore displayed individually in the species status section summaries above (see Section 2.2).

Thus, for some of the work being contemplated here, the impacts that previous Federal, state, and private activities in the action area have had on the species are indistinguishable from those effects summarized below and in the previous section on the species' rangewide status. The same is true with respect to the species' habitat: for some of the work contemplated, the environmental baseline is the result of these activities' rangewide effects on the PBFs that are essential to the conservation of the species. However, as noted previously, some of the proposed work has a more limited geographic scope. If the work would not take place in marine or mainstem areas or would not be randomly distributed throughout the majority of a given species' range, then the action area can be narrowed for a more specific analysis—and in those instances, the relevant local status information will be taken into account for both species and critical habitat.

Analysis at the ESU/DPS level will be performed for all permits listed in Table 1. The permits for which population-level analysis will be performed are:

- Permit 16122-3R
- Permit 23649
- Permit 23843

2.4.1 Summary for all Listed Species

2.4.1.1 Factors Limiting Recovery

The best scientific information presently available demonstrates that a multitude of factors, past and present, have contributed to the decline of west coast salmonids, eulachon, and green sturgeon. NMFS' status reviews, Technical Recovery Team publications, and recovery plans for the listed species considered in this opinion identify several factors that have caused them to decline, as well as those that prevent them from recovering (many of which are the same). Very generally, these include harvest and hatchery practices and habitat degradation and curtailment caused by human development and resource extraction. NMFS' decisions to list the species identified a variety of factors that were limiting their recovery. None of these documents identifies scientific research as either a cause for decline or a factor preventing their recovery. See tables 2 and 24 for summaries of the major factors limiting recovery of the listed species and how various factors have degraded PBFs and harmed listed species considered in this opinion. Also, please see section 2.2 for information regarding how climate change has affected and is affecting species and habitat in the action areas. Climate change was not generally considered a relevant factor when the species were listed and the critical habitat designated, but it is now.

As a general matter, all the species considered in this opinion have at least some biological requirements that are not being met in the action areas. The listed species are still experiencing the impact of a variety of past and ongoing Federal, state, and private activities in the action areas and that impact is expressed in the limiting factors described above and in the species status sections—all of which, in combination, are currently keeping the species from recovering and actively preventing them from having all their biological requirement met in the action area.

For detailed information on how various factors have degraded PBFs and harmed listed species, please see the references listed in the species and critical habitat status sections.

Research Effects

Although not identified as a factor for decline or a threat preventing recovery for any species, scientific research and monitoring activities have the potential to affect the species' survival and recovery by killing listed salmonids—whether intentionally or not. For the year 2020, NMFS has issued numerous research section 10(a)(1)(A) scientific research permits allowing listed species to be taken and sometimes killed. NMFS has also issued numerous authorizations for state and tribal scientific research programs under ESA section 4(d). Table 25 displays the total take for the ongoing research authorized under ESA sections 4(d) and 10(a)(1)(A).

Table 25. Total expected take of the ESA listed species for scientific research and monitoring already approved for 2020

Species	Life Stage	Origin	Total Take	Lethal Take	Percent of ESU/DPS taken	Percent of ESU/DPS killed
Puget Sound Chinook salmon	Adult	Natural	959	35	4.463	0.163
		Listed Hatchery Intact Adipose	937	10	11.561[a]	0.388[a]
		Listed Hatchery Adipose Clip	1,151	60		
	Juvenile	Natural	500,159	10,015	15.810	0.317
		Listed Hatchery Intact Adipose	91,513	3,020	1.225	0.040
		Listed Hatchery Adipose Clip	251,755	12,144	0.531	0.026
Puget Sound Steelhead	Adult	Natural	2,003	42	10.583[b]	0.252[b]
		Listed Hatchery Intact Adipose	22	0		
		Listed Hatchery Adipose Clip	34	7		
	Juvenile	Natural	65,448	1,450	2.961	0.066
		Listed Hatchery Intact Adipose	2,391	38	2.125	0.034
		Listed Hatchery Adipose Clip	5,262	108	4.784	0.098
Upper Columbia River Steelhead	Adult	Natural	235	4	12.170	0.207
		Listed Hatchery Intact Adipose	94	2	8.083	0.172
		Listed Hatchery Adipose Clip	219	6	4.125	0.113
	Juvenile	Natural	47,233	963	23.690	0.483
		Listed Hatchery Intact Adipose	3,418	99	2.466	0.071
		Listed Hatchery Adipose Clip	11,334	278	1.648	0.040
	Adult	Natural	1,432	20	28.345	0.396

Table 25. Total expected take of the ESA listed species for scientific research and monitoring already approved for 2020

Species	Life Stage	Origin	Total Take	Lethal Take	Percent of ESU/DPS taken	Percent of ESU/DPS killed
Middle Columbia River Steelhead		Listed Hatchery Intact Adipose	169	6	150.893	5.357
		Listed Hatchery Adipose Clip	933	12	208.259	2.679
	Juvenile	Natural	118,335	2,503	29.025	0.614
		Listed Hatchery Intact Adipose	8,682	117	7.859	0.106
		Listed Hatchery Adipose Clip	900	43	0.202	0.010
Lower Columbia River Chinook salmon	Adult	Natural	325	16	1.103	0.054
		Listed Hatchery Intact Adipose	12	0	0.420[a]	0.034[a]
		Listed Hatchery Adipose Clip	150	13		
	Juvenile	Natural	768,214	10,586	6.541	0.090
		Listed Hatchery Intact Adipose	315	36	0.033	0.004
		Listed Hatchery Adipose Clip	53,857	1,564	0.172	0.005
Lower Columbia River coho salmon	Adult	Natural	1,423	18	4.765	0.060
		Listed Hatchery Intact Adipose	31	0	7.280[a]	0.466[a]
		Listed Hatchery Adipose Clip	609	41		
	Juvenile	Natural	180,088	2,556	27.226	0.386
		Listed Hatchery Intact Adipose	560	112	0.224	0.045
		Listed Hatchery Adipose Clip	53,496	1,855	0.734	0.025
Lower Columbia River Steelhead	Adult	Natural	2,834	32	21.935	0.248
		Listed Hatchery Adipose Clip	86	4	0.386	0.018
	Juvenile	Natural	68,527	1,178	19.460	0.335

Table 25. Total expected take of the ESA listed species for scientific research and monitoring already approved for 2020

Species	Life Stage	Origin	Total Take	Lethal Take	Percent of ESU/DPS taken	Percent of ESU/DPS killed
		Listed Hatchery Intact Adipose	3	0	0.033	0.000
		Listed Hatchery Adipose Clip	40,946	615	3.420	0.051
Columbia River chum salmon	Adult	Natural	40	6	0.376	0.056
		Listed Hatchery Intact Adipose	1	0	0.235	0.000
	Juvenile	Natural	39,164	498	0.591	0.008
		Listed Hatchery Intact Adipose	567	18	0.094	0.003
		Listed Hatchery Adipose Clip	10	0	-	-
Upper Willamette River Chinook salmon	Adult	Natural	207	6	2.029	0.059
		Listed Hatchery Adipose Clip	171	13	0.543	0.041
	Juvenile	Natural	44,727	702	3.691	0.058
		Listed Hatchery Intact Adipose	46	3	1.092	0.071
		Listed Hatchery Adipose Clip	8,720	277	0.185	0.006
Upper Willamette River Steelhead	Adult	Natural	228	4	7.830	0.137
	Juvenile	Natural	12,067	238	8.595	0.170
Southern Oregon/Northern California Coast coho salmon	Adult	Natural	1,636	17	18.047	0.188
		Listed Hatchery Intact Adipose	1,795	4	21.813[a]	0.137[a]
		Listed Hatchery Adipose Clip	590	11		
	Juvenile	Natural	195,014	2,850	9.685	0.142
		Listed Hatchery Intact Adipose	10,771	629	1.873	0.109
		Listed Hatchery Adipose Clip	1,538	40	0.769	0.020

Table 25. Total expected take of the ESA listed species for scientific research and monitoring already approved for 2020

Species	Life Stage	Origin	Total Take	Lethal Take	Percent of ESU/DPS taken	Percent of ESU/DPS killed
Northern California Steelhead	Adult	Natural	925	19	12.810	0.263
	Juvenile	Natural	231,613	3,514	28.198	0.428
California Coastal Chinook salmon	Adult	Natural	475	15	6.753	0.213
	Juvenile	Natural	297,044	3,800	23.241	0.297
Sacramento River winter-run Chinook salmon	Adult	Natural	169	17	80.476	8.095
		Listed Hatchery Adipose Clip	89	52	3.987	2.330
	Juvenile	Natural	171,016	5,037	87.542	2.578
		Listed Hatchery Adipose Clip	10,836	926	5.418	0.463
Central Valley spring-run Chinook salmon	Adult	Natural	502	23	13.469	0.617
		Listed Hatchery Adipose Clip	417	51	18.346	2.244
	Juvenile	Natural	865,438	16,881	111.601	2.177
		Listed Hatchery Adipose Clip	15,061	1,212	0.694	0.056
California Central Valley Steelhead	Adult	Natural	3,593	81	213.108	4.804
		Listed Hatchery Adipose Clip	646	56	16.753	1.452
	Juvenile	Natural	66,332	2,057	10.522	0.326
		Listed Hatchery Adipose Clip	24,245	1,637	1.515	0.102
Central California Coast coho salmon	Adult	Natural	3,656	53	189.234	2.743
		Listed Hatchery Intact Adipose	1,690	33	516.820	10.092
	Juvenile	Natural	177,357	3,207	112.159	2.028
		Listed Hatchery Intact Adipose	59,340	1,449	35.773	0.874
	Adult	Natural	2,590	45	118.427	2.058

Table 25. Total expected take of the ESA listed species for scientific research and monitoring already approved for 2020

Species	Life Stage	Origin	Total Take	Lethal Take	Percent of ESU/DPS taken	Percent of ESU/DPS killed
Central California Coast Steelhead		Listed Hatchery Adipose Clip	487	12	12.597	0.310
	Juvenile	Natural	209,703	4,775	84.296	1.919
		Listed Hatchery Intact Adipose	6,200	124	-	-
		Listed Hatchery Adipose Clip	12,780	352	1.970	0.054
South-Central California Coast Steelhead	Adult	Natural	1,178	12	169.496	1.727
	Juvenile	Natural	43,498	1,154	55.021	1.460
Southern California Steelhead	Adult	Natural	45	8	-[c]	-[c]
	Juvenile	Natural	21,700	585		
Southern DPS Eulachon	Adult	Natural	33,822	31,054	0.110[d]	0.102[d]
	Subadult	Natural	1,030	1,030		
	Juvenile	Natural	540	456		
Southern DPS green sturgeon	Adult	Natural	477	10	22.650	0.475
	Subadult	Natural	66	5	0.597	0.045
	Juvenile	Natural	1,684	111	38.386	2.530
	Larvae	Natural	11,005	1,005	-	-
	Egg	Natural	1,350	1,350		

[a] Abundances for adult hatchery salmonids are Listed Hatchery Adipose Clip and Listed Hatchery Intact Adipose combined.
[b] Abundances for all adult components are combined.
[c] Reliable abundance data were not available for this calculation.
[d] Abundance for these species are only known for the adult life stage which is used to represent the entire DPS.

Actual take levels associated with these activities are almost certain to be a substantially lower than the permitted levels. There are three reasons for this. First, most researchers do not handle the full number of juveniles or adults they are allowed. That is, for the vast majority of scientific research permits, history has shown that researchers generally take far fewer salmonids than the allotted number of salmonids every year. Over the past five years (2014-2019) all Section 10(a)(1)(A) and 4(d) permits reporting take for ESA-listed steelhead and salmon in the West Coast Region resulted in researchers using only 16% of the requested handling take and 12% of the requested mortalities. Second, we purposefully inflate our take and mortality estimates for each proposed study to account for the effects of potential accidental deaths. Therefore it is very likely that far fewer fish would be killed under any given research project than the researchers are permitted. Third, for juvenile salmonids, many of the young fish that may be affected would not actually be in the smolt stage. As a result, all non-adult fish are simply be described as "juveniles," which means they may actually be yearlings, parr, or even fry: life stages represented by multiple spawning years and many more individuals than reach the smolt stage—perhaps as much as an order of magnitude more. Therefore, the estimates of percentages of ESUs/DPSs taken were derived by (a) conservatively estimating the actual number of fish to be taken, (b) overestimating the number of fish likely to be killed, and (c) treating each dead juvenile fish as part of the same year class. Thus, the actual numbers of salmonids the research is likely to kill are undoubtedly smaller than the stated figures.

2.5 Effects of the Action

Under the ESA, "effects of the action" are all consequences to listed species or critical habitat that are caused by the proposed action, including the consequences of other activities that are caused by the proposed action. A consequence is caused by the proposed action if it would not occur but for the proposed action and it is reasonably certain to occur. Effects of the action may occur later in time and may include consequences occurring outside the immediate area involved in the action (see 50 CFR 402.17). In our analysis, which describes the effects of the proposed action, we considered 50 CFR 402.17(a) and (b).

2.5.1 Effects on Critical Habitat

Full descriptions of effects of the proposed research activities are given in the following sections. In general, the permitted activities would be (1) electrofishing, (2) capturing fish with angling equipment, traps, and nets of various types, (3) collecting biological samples from live fish, and (4) collecting fish lethally for biological, pathological, or chemical analyses. All of these techniques are minimally intrusive in terms of their effect on habitat because they would involve very little, if any, disturbance of streambeds, adjacent riparian zones, or marine or estuarine substrate. Such sampling activities also affect small spatial areas and are brief in duration, so any effects are expected to be ephemeral and attenuate rapidly. Therefore, none of the activities analyzed in this Opinion will measurably affect any habitat PBF function or value described earlier (see section 2.2.2).

2.5.2 Effects on the Species

As discussed above, the proposed research activities would not measurable affect any of the listed species' habitat. The actions are therefore not likely to measurably affect any of the listed species by reducing that habitat's ability to contribute to their survival and recovery.

The primary effect of the proposed research will be on the listed species in the form of capturing and handling the fish. Capturing, handling, and releasing fish generally leads to stress and other sub-lethal effects that are difficult to assess in terms of their impact on individuals, let alone entire species. To conservatively analyze the potential effects of this kind of take we therefore use what we consider to be modest over estimates of mortalities (i.e. maximum mortality that could occur using non-lethal sampling methods): by doing that, we can be more certain we are capturing the full range of potential effects.

The following subsections describe the types of activities being proposed. Each is described in terms broad enough to apply to all the permits. The activities would be carried out by trained professionals using established protocols. The effects of the activities are well documented and discussed in detail below. No researcher would receive a permit unless the activities (e.g., electrofishing) incorporate NMFS' uniform, pre-established set of mitigation measures. These measures are described in Section 1.3 of this opinion. They are incorporated (where relevant) into every permit as part of the conditions to which a researcher must adhere.

Capture/handling

The primary effect of the proposed research on the listed species would be in the form of capturing and handling fish. We discuss effects from handling and anesthetizing fish, and the general effects of capture using seines and traps here. We discuss effects from other capture methods in more detail in the subsections below.

Harassment caused by capturing, handling, and releasing fish generally leads to stress and other sub-lethal effects that are difficult to assess in terms of their impact on individuals, populations, and species (Sharpe et al. 1998). Handling of fish may cause stress, injury, or death, which typically are due to overdoses of anesthetic, differences in water temperatures between the river and holding buckets, depleted dissolved oxygen in holding buckets, holding fish out of the water, and physical trauma. Stress on salmonids increases rapidly from handling if the water temperature exceeds 18ºC or dissolved oxygen is below saturation. Fish transferred to holding buckets can experience trauma if care is not taken in the transfer process, and fish can experience stress and injury from overcrowding in traps, nets, and buckets. Decreased survival of fish can result when stress levels are high because stress can be immediately debilitating and may also increase the potential for vulnerability to subsequent challenges (Sharpe et al. 1998). The permit conditions identified in Section 1.3 contain measures that mitigate factors that commonly lead to stress and trauma from handling, and thus minimize the harmful effects of capturing and handling fish. When these measures are followed, fish typically recover fairly rapidly from handling.

Electrofishing

Electrofishing is a process by which an electrical current is passed through water containing fish in order to stun them, which makes them easy to capture. It can cause a suite of effects ranging from disturbing the fish to killing them. The percentage of fish that are unintentionally killed by electrofishing varies widely depending on the equipment used, the settings on the equipment, and the expertise of the technician (Sharber and Carothers 1988, McMichael 1993, Dalbey et al. 1996; Dwyer and White 1997). Research indicates that using continuous direct current (DC) or low-frequency (30 Hz) pulsed DC waveforms produce lower spinal injury rates, particularly for salmonids (Fredenberg 1992, McMichael 1993, Sharber et al. 1994, Snyder 1995).

Most studies on the effects of electrofishing on fish have been conducted on adult fish greater than 300 mm in length (Dalbey et al. 1996). Electrofishing can have severe effects on adult salmonids. Adult salmonids can be injured or killed due to spinal injuries that can result from forced muscle contractions. Sharber and Carothers (1988) reported that electrofishing killed 50% of the adult rainbow trout in their study.

Spinal injury rates are substantially lower for juvenile fish than for adults. Smaller fish are subjected to a lower voltage gradient than larger fish (Sharber and Carothers 1988) and may, therefore, be subject to lower injury rates (e.g., Hollender and Carline 1994, Dalbey et al. 1996, Thompson et al. 1997). McMichael et al. (1998) reported a 5.1% injury rate for juvenile Middle Columbia River steelhead captured by electrofishing in the Yakima River subbasin.

When using appropriate electrofishing protocols and equipment settings, shocked fish normally revive quickly. Studies on the long-term effects of electrofishing indicate that even with spinal injuries, salmonids can survive long-term; however, severely injured fish may have stunted growth (Dalbey et al. 1996, Ainslie et al. 1998).

Permit conditions would require that all researchers follow NMFS' electrofishing guidelines (NMFS 2000). The guidelines require that field crews:

- Use electrofishing only when other survey methods are not feasible.
- Be trained by qualified personnel in equipment handling, settings, maintenance to ensure proper operating condition, and safety.
- Conduct visual searches prior to electrofishing on each date and avoid electrofishing near adults or redds. If an adult or a redd is detected, researchers must stop electrofishing at the research site and conduct careful reconnaissance surveys prior to electrofishing at additional sites.
- Test water conductivity and keep voltage, pulse width, and rate at minimal effective levels. Use only DC waveforms.
- Work in teams of two or more technicians to increase both the number of fish seen at one time and the ability to identify larger fish without having to net them. Working in teams allows netter(s) to remove fish quickly from the electrical field and to net fish farther from the anode, where the risk of injury is lower.
- Observe fish for signs of stress and adjust electrofishing equipment to minimize stress.
- Provide immediate and adequate care to any fish that does not revive immediately upon removal from the electrical current.

The preceding discussion focused on the effects backpack electrofishing and the ways those effects would be mitigated. In larger streams and rivers, electrofishing units are sometimes mounted on boats or rafts. These units often use more current than backpack electrofishing equipment because they need to cover larger and deeper areas. The environmental conditions in larger, more turbid streams can limit researchers' ability to minimize impacts on fish. As a result, boat electrofishing can have a greater impact on fish. Researchers conducting boat electrofishing must follow NMFS' electrofishing guidelines.

Gastric Lavage

Knowledge of the food and feeding habits of fish are important in the study of aquatic ecosystems. However, in the past, food habit studies required researchers to kill fish for stomach removal and examination. Consequently, several methods have been developed to remove stomach contents without injuring the fish. Most techniques use a rigid or semi-rigid tube to inject water into the stomach to flush out the contents.

Few assessments have been conducted regarding the mortality rates associated with nonlethal methods of examining fish stomach contents (Kamler and Pope 2001). However, Strange and Kennedy (1981) assessed the survival of salmonids subjected to stomach flushing and found no difference between stomach-flushed fish and control fish that were held for three to five days. In addition, when Light et al. (1983) flushed the stomachs of electrofished and anesthetized brook trout, survival was 100% for the entire observation period. In contrast, Meehan and Miller (1978) determined the survival rate of electrofished, anesthetized, and stomach-flushed wild and hatchery coho salmon over a 30-day period to be 87% and 84%, respectively.

Hook and Line/Angling

Fish caught with hook and line and released alive may still die due to injuries and stress they experience during capture and handling. Angling-related mortality rates vary depending on the type of hook (barbed vs barbless), the type of bait (natural vs artificial), water temperature, anatomical hooking location, species, and the care with which fish are handled and released (level of air exposure and length of time for hook removal).

The available information assessing hook and release mortality of adult steelhead suggests that hook and release mortality with barbless hooks and artificial bait is low. Nelson et al. (2005) reported an average mortality of 3.6% for adult steelhead that were captured using barbless hooks and radio tagged in the Chilliwack River, BC. The authors also note that there was likely some tag loss and the actual mortality might be lower. Hooton (1987) found catch and release mortality of adult winter steelhead to average 3.4% (127 mortalities of 3,715 steelhead caught) when using barbed and barbless hooks, bait, and artificial lures. Among 336 steelhead captured on various combinations of popular terminal gear in the Keogh River, the mortality of the combined sample was 5.1%. Natural bait had slightly higher mortality (5.6%) than did artificial lures (3.8%), and barbed hooks (7.3%) had higher mortality than barbless hooks (2.9%). Hooton (1987) concluded that catching and releasing adult steelhead was an effective mechanism for maintaining angling opportunity without negatively affecting stock recruitment. Reingold (1975) showed that adult steelhead hooked, played to exhaustion, and then released returned to their target spawning stream at the same rate as steelhead not hooked and played to exhaustion. Pettit (1977) found that egg viability of hatchery steelhead was not negatively affected by catch-and-release of pre-spawning adult female steelhead. Bruesewitz (1995) found, on average, fewer than 13% of harvested summer and winter steelhead in Washington streams were hooked in critical areas (tongue, esophagus, gills, eye). The highest percentage (17.8%) of critical area hookings occurred when using bait and treble hooks in winter steelhead fisheries.

The referenced studies were conducted when water temperatures were relatively cool, and primarily involve winter-run steelhead. Catch and release mortality of steelhead is likely to be higher if the activity occurs during warm water conditions. In a study conducted on the catch and release mortality of steelhead in a California river, Taylor and Barnhart (1999) reported over 80% of the observed mortalities occurred at stream temperatures greater than 21 degrees C. Catch and release mortality during periods of elevated water temperature are likely to result in post-release mortality rates greater than reported by Nelson et al. (2005) or Hooton (1987) because of warmer water and that fact that summer fish have an extended freshwater residence that makes them more likely to be caught. As a result, NOAA Fisheries expects steelhead hook and release mortality to be in the lower range discussed above.

Juvenile steelhead occupy many waters that are also occupied by resident trout species and it is not possible to visually separate juvenile steelhead from similarly-sized, stream-resident, rainbow trout. Because juvenile steelhead and stream-resident rainbow trout are the same species, are similar in size, and have the same food habits and habitat preferences, it is reasonable to assume that catch-and-release mortality studies on stream-resident trout are similar for juvenile steelhead. Where angling for trout is permitted, catch-and-release fishing with prohibition of use of bait reduces juvenile steelhead mortality more than any other angling regulatory change. Artificial lures or flies tend to superficially hook fish, allowing expedited hook removal with minimal opportunity for damage to vital organs or tissue (Muoneke and Childress, 1994). Many studies have shown trout mortality to be higher when using bait than when angling with artificial lures and/or flies (Taylor and White 1992; Schill and Scarpella 1995; Muoneke and Childress 1994; Mongillo 1984; Wydoski 1977; Schisler and Bergersen 1996). Wydoski (1977) showed the average mortality of trout, when using bait, to be more than four times greater than the mortality associated with using artificial lures and flies. Taylor and White (1992) showed average mortality of trout to be 31.4% when using bait versus 4.9 and 3.8% for lures and flies, respectively. Schisler and Bergersen (1996) reported average mortality of trout caught on passively fished bait to be higher (32%) than mortality from actively fished bait (21%). Mortality of fish caught on artificial flies was only 3.9%. In the compendium of studies reviewed by Mongillo (1984), mortality of trout caught and released using artificial lures and single barbless hooks was often reported at less than 2%.

Most studies have found a notable difference in the mortality of fish associated with using barbed versus barbless hooks (Huhn and Arlinghaus 2011; Bartholomew and Bohnsack 2005; Taylor and White 1992; Mongillo 1984; Wydoski 1977). Researchers have generally concluded that barbless hooks result in less tissue damage, they are easier to remove, and because they are easier to remove the handling time is shorter. In summary, catch-and-release mortality of steelhead is generally lowest when researchers are restricted to use of artificial flies and lures. As a result, all steelhead sampling via angling must be carried out using barbless artificial flies and lures.

Only a few reports are available that provide empirical evidence showing what the catch and release mortality is for Chinook salmon in freshwater. The ODFW has conducted studies of hooking mortality incidental to the recreational fishery for Chinook salmon in the Willamette River. A study of the recreational fishery estimates a per-capture hook-and-release mortality for wild spring Chinook salmon in Willamette River fisheries of 8.6% (Schroeder et al. 2000), which is similar to a mortality of 7.6% reported by Bendock and Alexandersdottir (1993) in the Kenai River, Alaska.

A second study on hooking mortality in the Willamette River, Oregon, involved a carefully controlled experimental fishery, and mortality was estimated at 12.2% (Lindsay et al. 2004). In hooking mortality studies, hooking location, gear type, and unhook time is important in determining the mortality of released fish. Fish hooked in the jaw or tongue suffered lower mortality (2.3 and 17.8% in Lindsay et al. (2004)) compared to fish hooked in the gills or esophagus (81.6 and 67.3%). Numerous studies have reported that deep hooking is more likely to result from using bait (e.g. eggs, prawns, or ghost shrimp) than lures (Lindsay et al. 2004). One theory is that bait tends to be passively fished and the fish is more likely to swallow bait than a lure. Passive angling techniques (e.g. drift fishing) are often associated with higher hooking mortality rates for salmon while active angling techniques (e.g. trolling) are often associated with lower hooking mortality rates (Cox-Rogers et al. 1999).

Catch and release fishing does not seem to have an effect on migration. Lindsay et al. (2004) noted that "hooked fish were recaptured at various sites at about the same frequency as control fish". Bendock and Alexandersdottir (1993) found that most of their tagged fish later turned up on the spawning grounds. Cowen et al. (2007) found little evidence of an adverse effect on spawning success for Chinook salmon.

Not all of the fish that are hooked are subsequently landed. We were unable to find any studies that measured the effect of hooking and losing a fish. However, it is reasonable to assume that nonlanded morality would be negligible, as fish lost off the hook are unlikely to be deeply hooked and would have little or no wound and bleeding (Cowen et al. 2007).

Based on the available data, the *U.S. v. Oregon* Technical Advisory Committee has adopted a 10% rate in order to make conservative estimates of incidental mortality in fisheries (TAC 2008). Nonetheless, given the fact that no ESA section 10 permit or 4(d) authorization may "operate to the disadvantage of the species," we allow no more than a three percent mortality rate for any listed species collected via angling, and all such activities must employ barbless artificial lures and flies.

Observation

For some parts of the proposed studies, listed fish would be observed but not captured (e.g., by snorkel surveys or from the banks). Observation without handling is the least disruptive method for determining a species' presence/absence and estimating their relative numbers. Its effects are also generally the shortest-lived and least harmful of the research activities discussed in this section because a cautious observer can effectively obtain data while only slightly disrupting the fishes' behavior. Fry and juveniles frightened by the turbulence and sound created by observers are likely to seek temporary refuge in deeper water or behind or under rocks or vegetation. In extreme cases, some individuals may leave a particular pool or habitat type and then return when observers leave the area. At times, the research involves observing adult fish—which are more sensitive to disturbance. During some of the research activities discussed below, redds may be visually inspected, but per NMFS' pre-established mitigation measures (included in state fisheries agency submittals), would not be walked on. Harassment is the primary form of take associated with these observation activities, and few if any injuries (and no deaths) are expected to occur—particularly in cases where the researchers observe from the stream banks rather than in the water. Because these effects are so small, there is little a researcher can do to mitigate them except to avoid disturbing sediments, gravels, and, to the extent possible, the fish themselves, and allow any disturbed fish the time they need to reach cover.

Sacrifice (Intentionally Killing)

In some instances, it is necessary to kill a captured fish in order to gather whatever data a study is designed to produce. In such cases, determining effect is a very straightforward process: the sacrificed fish, if they are juveniles, are forever removed from the gene pool and the effect of their deaths is weighed in the context that the effect on their listed unit and, where possible, their local population. If the fish are adults, the effect depends upon whether they are killed before or after they have a chance to spawn. If they are killed after they spawn, there is very little overall effect. Essentially, it amounts to removing the nutrients their bodies would have provided to the spawning grounds. If they are killed before they spawn, not only are they removed from the population, but so are all their potential progeny. Thus, killing pre-spawned adults has the greatest potential to affect the listed species. Because of this, NMFS only very rarely allows pre-spawned adults to be sacrificed. And, in almost every instance where it is allowed, the adults are stripped of sperm and eggs so their progeny can be raised in a controlled environment such as a hatchery—thereby greatly decreasing the potential harm posed by sacrificing the adults. As a general rule, adults are not sacrificed for scientific purposes and no such activity is considered in this opinion.

Screw trapping

Smolt, rotary screw (and other out-migration) traps, are generally used to obtain information on natural population abundance and productivity. On average, they achieve a sample efficiency of four to 20% of the emigrating population from a river or stream--depending on river size. Although under some conditions traps may achieve a higher efficiency for a relatively short period of time (NMFS 2003b). Based on years of sampling at hundreds of locations under hundreds of scientific research authorizations, we would expect the mortality rates for fish captured at rotary screw type traps to be one percent or less.

The trapping, capturing, or collecting and handling of juvenile fish using traps is likely to cause some stress on listed fish. However, fish typically recover rapidly from handling procedures. The primary factors that contribute to stress and mortality from handling are excessive doses of anesthetic, differences in water temperature, dissolved oxygen conditions, the amount of time that fish are held out of water, and physical trauma. Stress on salmonids increases rapidly from handling if the water temperature exceeds 64.4 degrees F (18 degrees C) or if dissolved oxygen is below saturation. Additionally, stress can occur if there are more than a few degrees difference in water temperature between the stream/river and the holding tank.

The potential for unexpected injuries or mortalities among listed fish is reduced in a number of ways. These can be found in the individual study protocols and in the permit conditions stated earlier. In general, screw traps are checked at least daily and usually fish are handled in the morning. This ensures that the water temperature is at its daily minimum when fish are handled. Also, fish may not be handled if the water temperature exceeds 69.8 degrees Fahrenheit (21 degrees C). Great care must be taken when transferring fish from the trap to holding areas and the most benign methods available are used—often this means using sanctuary nets when transferring fish to holding containers to avoid potential injuries. The investigators' hands must be wet before and during fish handling. Appropriate anesthetics must be used to calm fish subjected to collection of biological data. Captured fish must be allowed to fully recover before being released back into the stream and will be released only in slow water areas. And often, several other stringent criteria are applied on a case-by case basis: safety protocols vary by river velocity and trap placement, the number of times the traps are checked varies by water and air temperatures, the number of people working at a given site varies by the number of outmigrants expected, etc. All of these protocols and more are used to make sure the mortality rates stay at one percent or lower.

Gill or Tangle Netting

Gill and tangle netting techniques utilize a net suspended in the water column at target depths, having a top net with floats and a bottom net with weights, and a mesh designed to capture fish by entangling their gills. Researchers select the appropriate mesh size depending on their target species. Tangle nets have smaller mesh sizes than gill nets, and are designed to capture fish by the snout or jaw rather than the gills. However, a tangle net may act as a gill net for fish that are smaller than the target size.

Gill nets have long been used in commercial fisheries, and may be selected for research when targeting specific water column depths or sampling in large bays or estuaries. Gill nets are recognized as having high mortality rates for captured fish, although the mortality rates are highly correlated with soak time, and have been observed to range from only 2.5% mortality for short (40 minute) soak times to over 60% for longer (140 minute) soak times (Buchanan et al. 2002). Tangle nets can efficiently capture salmonids in large rivers and estuaries, and have been used successfully for the lower Columbia River spring Chinook salmon commercial fishery (Ashbrook et al. 2005, Vander Haegen et al. 2004).

Fish may be injured or die if they become physiologically exhausted in a tangle or gill net or if they sustain injuries such as abrasion or fin damage. Entanglement in nets can also damage the protective slime layer, making fish more susceptible to infections. Such injuries can result in immediate or delayed mortality (Vander Haegen et al. 2005). Buchanan et al. (2002) and Vander Haegen et al. (2005) emphasized that to minimize both immediate and delayed mortality of entanglement nets researchers must employ best practices including using short nets with short soak times, and removing fish from the net carefully and promptly after capture. As with other types of capture, fish stress increases rapidly if the water temperature exceeds 18ºC or dissolved oxygen is below saturation.

Tagging/Marking

Techniques such as Passive Integrated Transponder (PIT) tagging, coded wire tagging, fin-clipping, and the use of radio transmitters are common to many scientific research efforts using listed species. All sampling, handling, and tagging procedures have an inherent potential to stress, injure, or even kill the marked fish. This section discusses each of the marking processes and its associated risks.

A PIT tag is an electronic device that relays signals to a radio receiver; it allows salmonids to be identified whenever they pass a location containing such a receiver (e.g., any of several dams) without researchers having to handle the fish again. The tag is inserted into the body cavity of the fish just in front of the pelvic girdle. The tagging procedure requires that the fish be captured and extensively handled; therefore, any researchers engaged in such activities will follow the conditions listed previously in this Opinion (as well as any permit-specific conditions) to ensure that the operations take place in the safest possible manner. In general, the tagging operations will take place where there is cold water of high quality, a carefully controlled environment for administering anesthesia, sanitary conditions, quality control checking, and a carefully regulated holding environment where the fish can be allowed to recover from the operation.

PIT tags have very little effect on growth, mortality, or behavior. The few reported studies of PIT tags have shown no effect on growth or survival (Prentice et al. 1987; Jenkins and Smith 1990; Prentice et al. 1990). For example, in a study between the tailraces of Lower Granite and McNary Dams (225 km), Hockersmith et al. (2000) concluded that the performance of yearling Chinook salmon was not adversely affected by gastrically- or surgically implanted sham radio tags or PIT-tags. Additional studies have shown that growth rates among PIT-tagged Snake River juvenile fall Chinook salmon in 1992 (Rondorf and Miller 1994) were similar to growth rates for salmon that were not tagged (Conner et al. 2001). Prentice and Park (1984) also found that PIT-tagging did not substantially affect survival in juvenile salmonids.

Coded wire tags (CWTs) are made of magnetized, stainless-steel wire. They bear distinctive notches that can be coded for such data as species, brood year, hatchery of origin, and so forth (Nielsen 1992). The tags are intended to remain within the animal indefinitely, consequently making them ideal for long-term, population-level assessments of Pacific Northwest salmon. The tag is injected into the nasal cartilage of a salmon and therefore causes little direct tissue damage (Bergman et al.

1968; Bordner et al. 1990). The conditions under which CWTs may be inserted are similar to those required for applying PIT-tags.

A major advantage to using CWTs is the fact that they have a negligible effect on the biological condition or response of tagged salmon; however, if the tag is placed too deeply in the snout of a fish, it may kill the fish, reduce its growth, or damage olfactory tissue (Fletcher et al. 1987; Peltz and Miller 1990). This latter effect can create problems for species like salmon because they use olfactory clues to guide their spawning migrations (Morrison and Zajac 1987).

In order for researchers to be able to determine later (after the initial tagging) which fish possess CWTs, it is necessary to mark the fish externally—usually by clipping the adipose fin—when the CWT is implanted (see text below for information on fin clipping). One major disadvantage to recovering data from CWTs is that the fish must be killed in order for the tag to be removed. However, this is not a significant problem because researchers generally recover CWTs from salmon that have been taken during the course of commercial and recreational harvest (and are therefore already dead).

The other primary method for tagging fish is to implant them with acoustic tags, radio tags, or archival loggers. There are two main ways to accomplish this and they differ in both their characteristics and consequences. First, a tag can be inserted into a fish's stomach by pushing it past the esophagus with a plunger. Stomach insertion does not cause a wound and does not interfere with swimming. This technique is benign when salmon are in the portion of their spawning migrations during which they do not feed (Nielsen 1992). In addition, for short-term studies, stomach tags allow faster post-tagging recovery and interfere less with normal behavior than do tags attached in other ways.

The second method for implanting tags is to place them within the body cavities of (usually juvenile) salmonids. These tags do not interfere with feeding or movement. However, the tagging procedure is difficult, requiring considerable experience and care (Nielsen 1992). Because the tag is placed within the body cavity, it is possible to injure a fish's internal organs. Infections of the sutured incision and the body cavity itself are also possible, especially if the tag and incision are not treated with antibiotics (Chisholm and Hubert 1985; Mellas and Haynes 1985).

Fish with internal tags often die at higher rates than fish tagged by other means because tagging is a complicated and stressful process. Mortality is both acute (occurring during or soon after tagging) and delayed (occurring long after the fish have been released into the environment). Acute mortality is caused by trauma induced during capture, tagging, and release. It can be reduced by handling fish as gently as possible. Delayed mortality occurs if the tag or the tagging procedure harms the animal in direct or subtle ways. Tags may cause wounds that do not heal properly, may make swimming more difficult, or may make tagged animals more vulnerable to predation (Howe and Hoyt 1982; Matthews and Reavis 1990; Moring 1990). Tagging may also reduce fish growth by increasing the energetic costs of swimming and maintaining balance. As with the other forms of tagging and marking, researchers will keep the harm caused by tagging to a minimum by following the conditions in the permits as well as any other permit-specific requirements.

Tissue Sampling

Tissue sampling techniques such as fin-clipping are common to many scientific research efforts using listed species. All sampling, handling, and clipping procedures have an inherent potential to stress, injure, or even kill the fish. This section discusses tissue sampling processes and its associated risks.

Fin clipping is the process of removing part or all of one or more fins to obtain non-lethal tissue samples and alter a fish's appearance (and thus make it identifiable). When entire fins are removed, it is expected that they will never grow back. Alternatively, a permanent mark can be made when only a part of the fin is removed or the end of a fin or a few fin rays are clipped. Although researchers have used all fins for marking at one time or another, the current preference is to clip the adipose, pelvic, or pectoral fins. Marks can also be made by punching holes or cutting notches in fins, severing individual fin rays (Welch and Mills 1981), or removing single prominent fin rays (Kohlhorst 1979). Many studies have examined the effects of fin clips on fish growth, survival, and behavior. The results of these studies are somewhat varied; however, it can be said that fin clips do not generally alter fish growth. Studies comparing the growth of clipped and unclipped fish generally have shown no differences between them (e.g., Brynildson and Brynildson 1967). Moreover, wounds caused by fin clipping usually heal quickly—especially those caused by partial clips.

Mortality among fin-clipped fish is also variable. Some immediate mortality may occur during the marking process, especially if fish have been handled extensively for other purposes (e.g., stomach sampling). Delayed mortality depends, at least in part, on fish size; small fishes have often been found to be susceptible to it and Coble (1967) suggested that fish shorter than 90 mm are at particular risk. The degree of mortality among individual fishes also depends on which fin is clipped. Studies show that adipose- and pelvic-fin-clipped coho salmon fingerlings have a 100% recovery rate (Stolte 1973). Recovery rates are generally recognized as being higher for adipose- and pelvic-fin-clipped fish in comparison to those that are clipped on the pectoral, dorsal, and anal fins (Nicola and Cordone 1973). Clipping the adipose and pelvic fins probably kills fewer fish because these fins are not as important as other fins for movement or balance (McNeil and Crossman 1979). Mortality is generally higher when the major median and pectoral fins are clipped. Mears and Hatch (1976) showed that clipping more than one fin may increase delayed mortality, but other studies have been less conclusive.

Trawls

Trawls are cone-shaped, mesh nets that are towed, often, along benthic habitat (Hayes 1983, Hayes et al. 1996). Rectangular doors, attached to the towing cables, keep the mouth of the trawl open. Most trawls are towed behind a boat, but small trawls can be operated by hand. As fish enter the trawl, they tire and fall to the codend of the trawl. Mortality and injury rates associated with trawls can be high, particularly for small or fragile fish. Fish can be crushed by debris or other fish caught in the net. However, all of the trawling considered in this opinion is midwater trawling which may be less likely to capture heavy debris loads than benthic or demersal trawl sampling. Depending on mesh size, some small fish are able to escape the trawl through the netting. However, not all fish that escape the trawl are uninjured, as fish may be damaged while passing through the netting. Short duration trawl hauls (5 to 10 minutes maximum) may reduce injuries (Hayes 1983, Stickney 1983, Hayes et al. 1996).

Weirs

Capture of adult salmonids by weirs is common practice in order to collect information; (1) enumerate adult salmon and steelhead entering the watershed; (2) determine the run timing of adult salmon and steelhead entering the watershed; (3) estimate the age, sex and length composition of the salmon escapement into the watershed; and (4) used to determine the genetic composition of fish passing through the weir (i.e. hatchery versus natural). Information pertaining to the run size, timing, age, sex and genetic composition of salmon and steelhead returning to the respective watershed will provide managers valuable information to refine existing management strategies.

Some weirs have a trap to capture fish, while other weirs have a video or DIDSON sonar to record fish migrating through the weir. Weirs with or without a trap, have the potential to delay migration. All weir projects will adhere to the draft NMFS West Coast Region Weir Guidelines and have included detailed descriptions of the weirs. The Weir Guidelines require the following: (1) traps must be checked and emptied daily, (2) all weirs including video and DIDSON sonar weirs must be inspected and cleaned of any debris daily, (3) the development and implementation of monitoring plans to assess passage delay, and (4) a development and implementation of a weir operating plan. These guidelines are intended to help improve fish weir design and operation in ways which will limit fish passage delays and increase weir efficiency.

2.5.3 Species-specific Effects of Each Permit

In previous sections, we estimated the annual abundance of adult and juvenile listed salmonids, eulachon, and green sturgeon. Since there are no measurable habitat effects, the analysis will consist primarily of examining directly measurable impacts of proposed activities on abundance. Abundance effects are themselves relevant to extinction risk, are directly related to productivity effects, and are somewhat but less directly to structure and diversity effects. Examining the magnitude of these effects at the individual and, where possible, population levels is the best way to determine effects at the species level.

In conducting the following analyses, we have tied the effects of each proposed action to its impacts on individual populations (or population groups) wherever it was possible to do so. In those instances, the status of the local population will be discussed and taken into account. In other instances, the nature of the project (i.e., it is broadly distributed or situated in mainstem habitat) is such that the take cannot reliably be assigned to any population or group of populations. In those cases, the effects of the action are measured in terms of how they are expected to affect each listed unit's total abundance by origin (natural or hatchery) and life stage (adult, juvenile, etc.)—rather than at the population scale.

The analysis process relies on multiple sources of data. In Section 2.2.1 (Status of the Species), we estimated the average annual abundance for the species considered in this document. For most of the listed species, we estimated abundance for adult returning fish and outmigrating smolts. These data come from estimates compiled by our Science Centers for the species status reviews, which are updated every five years. Additional data sources include state agencies (i.e. CDFW, Idaho Department of Fish and Wildlife, ODFW, and WDFW), county and local agencies, and educational and non-profit institutions. These sources are vetted for scientific accuracy before their use. For hatchery-origin juvenile salmonids, we use hatchery production goals. Table 26 displays the estimated annual abundance of the listed species.

Table 26. Estimated annual abundance of ESA listed fish

Species	Life Stage	Origin	Abundance
Puget Sound Chinook salmon	Adult	Natural	21,486
		Listed Hatchery, Clipped and Intact[a]	18,060
	Juvenile	Natural	3,163,652
		Listed Hatchery Intact Adipose	7,470,630
		Listed Hatchery Adipose Clip	47,372,500
Puget Sound Steelhead	Adult	Listed Hatchery and Natural-origin[b]	19,456
	Juvenile	Natural	2,210,140
		Listed Hatchery Intact Adipose	112,500
		Listed Hatchery Adipose Clip	110,000
Upper Columbia River Steelhead	Adult	Natural	1,931
		Listed Hatchery Intact Adipose	1,163
		Listed Hatchery Adipose Clip	5,309
	Juvenile	Natural	199,380
		Listed Hatchery Intact Adipose	138,601
		Listed Hatchery Adipose Clip	687,567
	Adult	Natural	5,052

Table 26. Estimated annual abundance of ESA listed fish

Species	Life Stage	Origin	Abundance
Middle Columbia River Steelhead		Listed Hatchery Intact Adipose	112
		Listed Hatchery Adipose Clip	448
	Juvenile	Natural	407,697
		Listed Hatchery Intact Adipose	110,469
		Listed Hatchery Adipose Clip	444,973
Lower Columbia River Chinook salmon	Adult	Natural	29,469
		Listed Hatchery, Clipped and Intact	38,594
	Juvenile	Natural	11,745,027
		Listed Hatchery Intact Adipose	962,458
		Listed Hatchery Adipose Clip	31,353,395
Lower Columbia River coho salmon	Adult	Natural	29,866
		Listed Hatchery, Clipped and Intact	8,791
	Juvenile	Natural	661,468
		Listed Hatchery Intact Adipose	249,784
		Listed Hatchery Adipose Clip	7,287,647
Lower Columbia River Steelhead	Adult	Natural	12,920
		Listed Hatchery, Clipped and Intact	22,297
	Juvenile	Natural	352,146
		Listed Hatchery Intact Adipose	9,138
		Listed Hatchery Adipose Clip	1,197,156
Columbia River chum salmon	Adult	Natural	10,644
		Listed Hatchery Intact Adipose	426

Table 26. Estimated annual abundance of ESA listed fish

Species	Life Stage	Origin	Abundance
	Juvenile	Natural	6,626,218
		Listed Hatchery Intact Adipose	601,503
Upper Willamette River Chinook salmon	Adult	Natural	10,203
		Listed Hatchery, Clipped and Intact	31,476
	Juvenile	Natural	1,211,863
		Listed Hatchery Intact Adipose	4,214
		Listed Hatchery Adipose Clip	4,709,045
Upper Willamette River Steelhead	Adult	Natural	2,912
	Juvenile	Natural	140,396
Southern Oregon/Northern California Coast coho salmon	Adult	Natural	9,065
		Listed Hatchery, Clipped and Intact	10,934
	Juvenile	Natural	2,013,593
		Listed Hatchery Intact Adipose	575,000
		Listed Hatchery Adipose Clip	200,000
Northern California Steelhead	Adult	Natural	7,221
	Juvenile	Natural	821,389
California Coastal Chinook salmon	Adult	Natural	7,034
	Juvenile	Natural	1,278,078
Sacramento River winter-run Chinook salmon	Adult	Natural	210
		Listed Hatchery Adipose Clip	2,232
	Juvenile	Natural	195,354
		Listed Hatchery Adipose Clip	200,000
Central Valley spring-run Chinook salmon	Adult	Natural	3,727
		Listed Hatchery Adipose Clip	2,273
	Juvenile	Natural	775,474

Table 26. Estimated annual abundance of ESA listed fish

Species	Life Stage	Origin	Abundance
		Listed Hatchery Adipose Clip	2,169,329
California Central Valley Steelhead	Adult	Natural	1,686
		Listed Hatchery Adipose Clip	3,856
	Juvenile	Natural	630,403
		Listed Hatchery Adipose Clip	1,600,653
Central California Coast coho salmon	Adult	Natural	1,932
		Listed Hatchery Intact Adipose	327
	Juvenile	Natural	158,130
		Listed Hatchery Intact Adipose	165,880
Central California Coast Steelhead	Adult	Natural	2,187
		Listed Hatchery Adipose Clip	3,866
	Juvenile	Natural	248,771
		Listed Hatchery Adipose Clip	648,891
South-Central California Coast Steelhead	Adult	Natural	695
	Juvenile	Natural	79,057
Southern DPS Eulachon[c]	Adult	Natural	32,029,043
Southern DPS green sturgeon	Adult	Natural	2,106
	Subadult	Natural	11,055
	Juvenile	Natural	4,387

[a] Abundances for adult hatchery salmonids are LHAC and LHIA combined.
[b] Abundances for all adult components are combined.
[c] Abundance for these species are only known for the adult life stage.

Permit 1336-9R

Under permit 1336-9R, Port Blakely Tree Farms (PBTF) would be renewing a permit that for nearly two decades has allowed them to capture, handle, and release listed salmonids on PBTF lands in Western Washington and Oregon. The researchers capture the fish, note their distribution, and examine the physical characteristics of the uppermost fish habitats to quantify conditions that appear to limit the fishes' distribution. The study would continue provide baseline data needed to adapt the riparian management prescriptions and conservation measures outlined in the PBTF's habitat conservation plan. All captured fish would be enumerated, identified by species and size class, and immediately released back to the point of their capture. The researchers are requesting the following amounts of take.

Table 27. Total Requested Take and Mortalities by Species, Age, Origin, and Action in Permit 1336-9R

Species	Life Stage	Origin	Take Action[a]	Requested Take	Lethal Take	Percent of ESU/DPS taken	Percent of ESU/DPS killed
Puget Sound Chinook salmon	Juvenile	Natural	C/H/R	20	1	<0.001	<0.001
Puget Sound Steelhead	Juvenile	Natural	C/H/R	25	1	0.001	<0.001
Lower Columbia River Chinook salmon	Juvenile	Natural	C/H/R	25	5	<0.001	<0.001
Lower Columbia River coho salmon	Juvenile	Natural	C/H/R	50	5	0.008	<0.001
Lower Columbia River Steelhead	Juvenile	Natural	C/H/R	50	4	0.014	0.001
Columbia River chum salmon	Juvenile	Natural	C/H/R	20	2	<0.001	<0.001
Upper Willamette River Chinook salmon	Juvenile	Natural	C/H/R	25	3	0.002	<0.001
Upper Willamette River Steelhead	Juvenile	Natural	C/H/R	50	2	0.036	0.001

[a] C=Capture, H=Handle, R=Release

Because the majority of the fish that would be captured are expected to recover with no adverse physiological, behavioral, or reproductive effects, the true effects of the proposed action considered herein are best seen in the context of the fish that are likely to be killed. To determine the effects of these losses, it is necessary to compare the numbers of fish that may be killed to the total abundance numbers expected for the population and species—these figures are represented in the last column of the table above.

As the table illustrates, the searchers would only take tiny fractions of any listed unit—and kill even smaller fractions of those units. Because the research would take place over such a broad area and in so many different tributaries, the potential losses cannot be ascribed to any population for any species and must therefore be viewed in the context of the listed units as individual wholes. As a result, though the research may in some instances have a very small impact on species abundance and productivity, it would in no measurable way impact structure or diversity for any species. And it is likely that the impacts would be even smaller than those laid out above. For this project over the past five years (2016-2019), the researchers have captured almost no individuals of any listed species and killed none. But even if all the fish that *could* be taken were taken in fact, that effect would be offset to some degree by the data to be gained—data that would be used to inform forest practices so that they may be carried out in a way that is least injurious to listed salmonids.

Permit 13791-7R

Under permit 13791-7R, the U.S. Fish and Wildlife Service Lodi Office would be renewing a permit that allows them to capture, handle, tag, tissue sample and release adult and juvenile SacR WR and CVS Chinook salmon, CCV steelhead, and sDPS green sturgeon while conducting research at long-term monitoring sites in the Sacramento and San Joaquin rivers and San Francisco Estuary. This permit also allows for the intentional directed mortality of a small subset of listed hatchery-origin juvenile SacR WR and CVS Chinook salmon, as well as larval green sturgeon. Capture methods may include Kodiak trawl, midwater trawl, beach seine, zooplankton net, larval net, gillnet, fyke net, purse seine, light trap, and boat electrofishing. All listed fish will be immediately collected from the sampling gears, allowed to recover, and released at the sampled location. A fin tissue sample will be collected from a subset of natural-origin SacR WR and CVSR Chinook salmon in order to identify their race.

The purpose of this work is to quantify the timing, distribution, and survival of salmon migrating through the Sacramento and San Joaquin river delta. This information is imperative for understanding the complex interactions among water operations, abiotic and biotic conditions, and population dynamics of species of management concern. The amount of take that the U.S. Fish and Wildlife Service Lodi Office is requesting is summarized in the following table.

Table 28. Total Requested Take and Mortalities by Species, Age, Origin, and Action in Permit 13791-7R

Species	Life Stage	Origin	Take Action[a]	Requested Take	Lethal Take	Percent of ESU/DPS taken	Percent of ESU/DPS killed
Sacramento River winter-run Chinook salmon	Adult	Natural	C/M, T, ST/R	27	2	12.857	0.952
		Listed Hatchery Adipose Clip	C/H/R	21	2	0.941	0.090
	Juvenile	Natural	C/H/R	1,856	43	0.950	0.022
		Natural	C/M, T, ST/R	840	6	0.430	0.003

Table 28. Total Requested Take and Mortalities by Species, Age, Origin, and Action in Permit 13791-7R

Species	Life Stage	Origin	Take Action[a]	Requested Take	Lethal Take	Percent of ESU/DPS taken	Percent of ESU/DPS killed
		Listed Hatchery Adipose Clip	C/H/R	1	0	<0.001	0.000
		Listed Hatchery Adipose Clip	IM	367	367	0.183	0.183
Central Valley spring-run Chinook salmon	Adult	Natural	C/M, T, ST/R	37	3	0.993	0.080
		Listed Hatchery Adipose Clip	C/H/R	27	3	1.188	0.132
	Juvenile	Natural	C/H/R	4,655	73	0.600	0.009
		Natural	C/M, T, ST/R	1,260	12	0.162	0.002
		Listed Hatchery Adipose Clip	IM	2,133	2,133	0.098	0.098
California Central Valley Steelhead	Adult	Natural	C/H/R	87	3	5.160	0.178
		Listed Hatchery Adipose Clip	C/H/R	87	3	2.256	0.078
	Juvenile	Natural	C/H/R	422	21	0.067	0.003
		Listed Hatchery Adipose Clip	C/H/R	872	29	0.054	0.002
Southern DPS green sturgeon	Adult	Natural	C/H/R	16	0	0.760	0.000
	Juvenile	Natural	C/H/R	54	0	1.231	
	Larvae	Natural	IM	10	10	-	-

[a] C=Capture, H=Handle, R=Release, M=Mark, T=Tag, ST=Sample Tissue, IM=Intentional Mortality

Because the majority of the fish that would be captured are expected to recover with no adverse physiological, behavioral, nor reproductive effects, the true effects of the proposed action considered herein are best seen in the context of the fish that are likely to be killed. To determine the effects of these losses, it is necessary to compare the numbers of fish that may be killed to the total abundance numbers expected for the population and species—these figures are represented in that last column of the table above.

As the table illustrates, for most species the researchers would take a small percent of any listed unit—and kill an even smaller percent of those units. Because the research would take place over such a broad area, and in the lower river reaches and San Francisco Estuary, the potential losses cannot be ascribed to any population for any species and must therefore be viewed in the context of the listed units as individual wholes. As a result, though the research may in some instances have a very small impact on species abundance and productivity, it would in no measurable way impact structure or diversity for any species.

It is also likely that the impacts would be even smaller than those laid out above. Reporting from the USFWS for this project indicates that over the past five years (2015-2019) the total handling take reported was 18.7% of the total amount authorized across all salmonid species for this permit. The actual lethal take was also low compared to what was authorized for this permit; total lethal take reported was 23.64% of the total lethal take authorized over the past five years. For adults, the proportion of take authorized that is actually used is even lower: over the same five-year period (2015-2019) there has been no lethal or non-lethal take of adult fish under this project. As a result, the actual numbers of ESA-listed fish taken as a result of this work, particularly for adults, are likely to be much lower than the figures presented above. Also, even if the losses were to be as large as those displayed in the table, the effects would to some extent be offset by the information generated from the research, which would be used to improve water operations and monitor habitat conditions and thereby improve the species' ability to survive and recover.

Permit 14516-3R

Under permit 14516-3R, the San Jose State University would be renewing a permit that currently allows them to annually capture, handle and release juvenile and adult CCC coho salmon and steelhead while conducting research in Gazos, Waddell, and Scott creek watersheds and Pescadero Creek and San Gregorio lagoons. Fish would be captured (using beach seines and backpack electrofishing), handled (weighed, measured, and checked for marks or tags), and released. A subsample of juvenile and all adult fish from both species would be marked and/or sampled for biological tissues. Carcasses would also be measured and sampled for biological tissues during spawning surveys. The purpose of the research is to continue monitoring coho salmon and steelhead year-to-year abundance, habitat utilization patterns, growth rates, and relative abundance among rearing life-history patterns. The resulting data would be used to guide management actions (including hatchery smolt releases) and help evaluate the relative importance of habitat types and how the interaction between coho salmon and steelhead affects juvenile rearing. The amount of take the San Jose State University is requesting is summarized in the following table.

Table 29. Total Requested Take and Mortalities by Species, Age, Origin, and Action in Permit 14516-3R

Species	Life Stage	Origin	Take Action[a]	Requested Take	Lethal Take	Percent of ESU/DPS taken	Percent of ESU/DPS killed
Central California	Adult	Natural	C/M, T, ST/R	5	0	0.259	0.000

Table 29. Total Requested Take and Mortalities by Species, Age, Origin, and Action in Permit 14516-3R

Species	Life Stage	Origin	Take Action[a]	Requested Take	Lethal Take	Percent of ESU/DPS taken	Percent of ESU/DPS killed
Coast coho salmon		Listed Hatchery Intact Adipose	O/ST D	115	0	-	-
	Spawned Adult/ Carcass	Natural	O/ST D	115	0	-	-
	Juvenile	Natural	C/M, T, ST/R	1,150	23	0.727	0.015
		Natural	C/H/R	2,200	44	1.391	0.028
		Listed Hatchery Intact Adipose	C/H/R	2,200	44	1.326	0.027
		Listed Hatchery Intact Adipose	C/M, T, ST/R	700	14	0.422	0.008
Central California Coast Steelhead	Adult	Natural	C/M, T, ST/R	142	0	6.493	0.000
	Juvenile	Natural	C/H/R	4,500	90	1.809	0.036
		Natural	C/M, T, ST/R	6,400	128	2.573	0.051

[a] C=Capture, H=Handle, R=Release, M=Mark, T=Tag, ST=Sample Tissue, O=Observe, D=Dead Animal

Because the majority of the fish that would be captured are expected to recover with no adverse physiological, behavioral, nor reproductive effects, the true effects of the proposed action considered herein are best seen in the context of the fish that are likely to be killed. To determine the effects of these losses, it is necessary to compare the numbers of fish that may be killed to the total abundance numbers expected for the population and species—these figures are represented in that last column of the table above.

Because the research would take place over such a broad area and in so many different tributaries, the potential losses cannot be ascribed to any population for any species and must therefore be viewed in the context of the listed units as individual wholes. As the table above illustrates, the overall effect on the Central California Coast coho salmon and Central California Coast Steelhead species' abundance would in all cases be very small. The researchers would only take tiny fractions of any listed unit—and kill even smaller fractions of those units (0.05% or less in all cases). Electrofishing would also occur in less than 5% of total available habitat. As a result, though the research may in some instances have a very small impact on species abundance and productivity, it would in no measurable way impact structure or diversity for any species.

It is also likely that the impacts would be even smaller than those laid out above. Reporting from past years of this project indicates that over the past five years the total handling take reported was 12.08% of the total amount authorized across all salmonid species. The actual lethal take was also low compared to what was authorized: total lethal take reported was 4.27% of the total lethal take authorized over the past five years. Also, even if the losses were to be as large as those displayed in the table, the effects would to some extent be offset by the information generated from the research, information that managers would use to help the species survive and recover.

Permit 14808-5R

Under permit 14808-5R, CDFW is renewing a permit that currently allows them to annually take juvenile and adult SacR winter-run and CVS Chinook salmon, CCV steelhead, and sDPS green sturgeon while conducting research in the Sacramento River in the California. Fish would be captured (using rotary screw traps, fyke traps, and beach seines), handled (weighed, measured, and checked for marks or tags), and released. Most of the juvenile and adult fish from all species would be sampled for biological tissues and a subsample would be anesthetized and tagged (PIT, elastomer, or acoustic tag). A subsample of hatchery-origin juvenile SacR Chinook salmon would be intentionally lethally taken for coded wire tag recovery. Juvenile and adult Chinook salmon and steelhead would also be observed through snorkel and video/DIDSON surveys. The amount of take CDFW is requesting is summarized in the following table.

Table 30. Total Requested Take and Mortalities by Species, Age, Origin, and Action in Permit 14808-5R

Species	Life Stage	Origin	Take Action[a]	Requested Take	Lethal Take	Percent of ESU/DPS taken	Percent of ESU/DPS killed
Sacramento River winter-run Chinook salmon	Adult	Natural	C/M, T, ST/R	100	2	47.619	0.952
		Natural	O/H	50	0	-	-
		Listed Hatchery Adipose Clip	C/M, T, ST/R	100	2	4.480	0.090
		Listed Hatchery Adipose Clip	O/H	25	0	-	-
	Juvenile	Natural	C/H/R	10	0	0.005	0.000
		Natural	C/M, T, ST/R	4,100	122	2.099	0.062
		Natural	O/H	100,000	0	-	-

Table 30. Total Requested Take and Mortalities by Species, Age, Origin, and Action in Permit 14808-5R

Species	Life Stage	Origin	Take Action[a]	Requested Take	Lethal Take	Percent of ESU/DPS taken	Percent of ESU/DPS killed
		Listed Hatchery Adipose Clip	C/M, T, ST/R	2,000	60	1.000	0.030
		Listed Hatchery Adipose Clip	IM	440	440	0.220	0.220
		Listed Hatchery Adipose Clip	O/H	200,000	0	-	-
Central Valley spring-run Chinook salmon	Adult	Natural	C/M, T, ST/R	200	5	5.366	0.134
		Natural	O/H	50	0	-	-
		Listed Hatchery Adipose Clip	C/M, T, ST/R	200	5	8.799	0.220
		Listed Hatchery Adipose Clip	O/H	100	0	-	-
	Juvenile	Natural	C/H/R	20	0	0.003	0.000
		Natural	C/M, T, ST/R	3,400	102	0.438	0.013
		Natural	O/H	75,000	0	-	-
California Central Valley Steelhead	Adult	Natural	C/M, T, ST/R	310	10	18.387	0.593
		Natural	O/H	100	0	-	-
		Listed Hatchery Adipose Clip	C/M, T, ST/R	1,510	30	39.160	0.778
	Juvenile	Natural	C/H/R	20	0	0.003	0.000
		Natural	C/M, T, ST/R	200	6	0.032	0.0010
		Natural	O/H	150,000	0	-	-
		Listed Hatchery Adipose Clip	C/M, T, ST/R	1,000	30	0.062	0.002
Southern DPS green sturgeon	Adult	Natural	C/M, T, ST/R	20	1	0.950	0.047
	Subadult	Natural	C/M, T, ST/R	15	1	0.136	0.009
	Juvenile	Natural	C/H/R	10	2	0.228	0.046

Table 30. Total Requested Take and Mortalities by Species, Age, Origin, and Action in Permit 14808-5R

Species	Life Stage	Origin	Take Action[a]	Requested Take	Lethal Take	Percent of ESU/DPS taken	Percent of ESU/DPS killed
		Natural	C/M, T, ST/R	10	1	0.228	0.023

[a] C=Capture, H=Handle, R=Release, M=Mark, T=Tag, ST=Sample Tissue, IM=Intentional Mortality, O/H=Observe/Harass

Because the majority of the fish that would be captured are expected to recover with no adverse physiological, behavioral, nor reproductive effects, the true effects of the proposed action considered herein are best seen in the context of the fish that are likely to be killed. To determine the effects of these losses, it is necessary to compare the numbers of fish that may be killed to the total abundance numbers expected for the population and species—these figures are represented in that last column of the table above.

As the table illustrates, the majority of take authorized for wild fish presents a small percent of any listed unit—and for all ESUs and DPSs this take would kill small fractions of those units. Because the research would take place over such a broad area and in so many different tributaries, the potential losses cannot be ascribed to any population for any species and must therefore be viewed in the context of the listed units as individual wholes. As a result, though the research may in some instances have a very small impact on species abundance and productivity, it would in no measurable way impact structure or diversity for any species.

In cases where the fraction of the ESU or DPS potentially killed is >0.5% the absolute number of adults requested is small, but these appear as large percentages because our current estimates of adult abundance are also low. In many cases these abundance estimates are known to be underestimates because they omit populations for which we don’t have data, or assume the lowest conservative figures determined to be reliable, and this permitted research is intended in part to provide more accurate estimates. However, it is likely that the impacts would be even smaller than those laid out above. Reporting from this project indicates that over the past five years (2015-2019) the total handling take reported was 21.6% of the total amount authorized across all salmonid species for this permit. The actual lethal take was also low compared to what was authorized for this permit; total lethal take reported was 15.6% of the lethal take authorized over the past five years. For adults, the proportion of take authorized that is actually used is even lower; over the same five-year period (2015-2019) researchers have only reported taking 3.4% of the total handling take and 9.7% of the lethal take of adult salmon and steelhead. As a result, the actual numbers of ESA-listed fish taken as a result of this work, particularly for adults, are likely to be much lower than the figures presented above. Also, even if the losses were to be as large as those displayed in the table, the effects would to some extent be offset by the information generated from the research, which would be used to improve water operations and monitor habitat conditions and thereby improve the species’ ability to survive and recover.

Permit 15215-2R

Under permit 15215-2R, CDFW would be renewing a permit that currently allows them to take juvenile and adult SacR WR Chinook salmon, CCC coho salmon, and SC steelhead for the California Statewide Fish Disease Monitoring Program. This permit would only allow the researchers to take dead or moribund fish in the event of an observed fish die-off. Dead or moribund fish found during such an event would be collected and tissue sampled. Animals determined to be moribund due to such an event would be collected by hand- or dip-net and euthanized before being tissue-sampled. The collected tissue samples would be evaluated for pathogens, immunological response, or DNA testing. The purpose of the research is to understand the role of disease when fish die-off events occur. Data identifying die-off causes would be used to inform fishery and water resource management in ways designed to help avoid future such events. The researchers are not proposing to capture or kill any healthy live fish; only dead fish and those that CDFW pathologists or veterinarians determine are severely compromised and unlikely to survive would be taken. The amount of take CDFW is requesting is summarized in the following table.

Table 31. Total Requested Take and Mortalities by Species, Age, Origin, and Action in Permit 15215-2R

Species	Life Stage	Origin	Take Action[a]	Requested Take	Lethal Take	Percent of ESU/DPS taken	Percent of ESU/DPS killed
Sacramento River winter-run Chinook salmon	Adult	Natural	O/ST D	35	0	-	-
		Listed Hatchery Adipose Clip	O/ST D	35	0	-	-
	Juvenile	Natural	O/ST D	40	0	-	-
		Listed Hatchery Adipose Clip	O/ST D	40	0	-	-
Central California Coast coho salmon	Adult	Natural	O/ST D	35	0	-	-
		Listed Hatchery Intact Adipose	O/ST D	35	0	-	-
	Juvenile	Natural	O/ST D	40	0	-	-
		Listed Hatchery Intact Adipose	O/ST D	40	0	-	-
	Adult	Natural	O/ST D	35	0	-	-

Table 31. Total Requested Take and Mortalities by Species, Age, Origin, and Action in Permit 15215-2R

Species	Life Stage	Origin	Take Action[a]	Requested Take	Lethal Take	Percent of ESU/DPS taken	Percent of ESU/DPS killed
Southern California Steelhead	Juvenile	Natural	O/ST D	40	0		

[a] O/ST D=Observe/Sample Tissue Dead Animal

Because any of the fish that would be collected will already be either dead or likely to die regardless of action taken by CDFW when encountered, the true effects of the proposed action considered herein are best seen in the context of the fish that would be killed as a result of the disease monitoring program, rather than the die-off event being monitored. Only fish that are moribund or displaying significant clinical signs of disease will be euthanized for sampling, and these fish are not expected to survive or be capable of contributing to the abundance of productivity of their respective ESUs or DPSs. Action by CDFW is not expected to change this and the effects of these proposed research activities on the species are expected to therefore be, for all intents and purposes, nonexistent. In addition, valuable knowledge CDFW is able to gain regarding disease mechanisms leading to die-off events is likely to improve manager's abilities to reduce these events, leading to increased survival of these species in the future.

Permit 15390-2R

Under permit 15390-2R, the Resource Conservation District (RCD) of the Santa Monica Mountains would be renewing a permit that currently allows them to take juvenile and adult SC steelhead in tributaries of Santa Monica Bay, California including Topanga, Malibu, and Arroyo Sequit creeks as well as Topanga and Malibu lagoons. Fish would be captured (using backpack electrofishing, fyke traps, and minnow traps), handled (weighed, measured, and checked for marks or tags), and released. A subsample of juveniles would be anesthetized, PIT-tagged, and sampled for biological tissues or stomach contents. The purpose of the research is to document the status of the population of Southern California steelhead in the coastal creeks of Santa Monica Bay, understand outmigration patterns, identify habitat constraints and restoration opportunities, and identify pathogens or diseases related to fish die-off events. The resulting data would be used to evaluate smolt production, recruitment, and seasonal habitat use in Topanga Creek and assess the contribution of various pathogens and diseases to mortality in Malibu creek. The researchers are requesting the following levels of take.

Table 32. Total Requested Take and Mortalities by Species, Age, Origin, and Action in Permit 15390-2R

Species	Life Stage	Origin	Take Action[a]	Requested Take	Lethal Take	Percent of ESU/DPS taken	Percent of ESU/DPS killed
Southern California Steelhead	Adult	Natural	C/H/R	10	0	-	-
		Natural	O/H	25	0		
	Juvenile	Natural	C/H/R	310	9		
		Natural	C/M, T, ST/R	980	27		
		Natural	O/H	4,500	0		
		Natural	O/ST D	10	0		

[a] C=Capture, H=Handle, R=Release, M=Mark, T=Tag, ST=Sample Tissue, O/H=Observe/Harass, D=Dead Animal

Because the majority of the fish that would be captured are expected to recover with no adverse physiological, behavioral, nor reproductive effects, the true effects of the proposed action considered herein are best seen in the context of the fish that are likely to be killed. For SC steelhead, we do not have sufficient reliable abundance data to compare the numbers of fish that may be killed to the total abundance numbers expected for the population and species. Researchers are not proposing to kill any adult steelhead. For juvenile steelhead, the researchers do not propose to intentionally kill juveniles, although up to 36 individuals may be killed as an inadvertent result of these activities.

It is also likely that even fewer juveniles would actually be killed as a result of this work. Reporting from this project indicates that over the past five years (2015-2019) the total handling take was 9.29% of the total amount authorized across all salmonid species, and no lethal take occurred. Also, even if the losses were to be as large as those displayed in the table, the effects would to some extent be offset by the information generated from the research, information that managers would use to help the species survive and recover.

Permit 16122-3R

Under Permit 16122-3R, the CCT—in coordination with the Washington Department of Fish & Wildlife (WDFW), NMFS, and the Bonneville Power Administration—would continue an ongoing UCR steelhead smolt trapping operation in the United States portion of the Okanogan River subbasin. The researchers would capture the fish using two floating rotary screw traps at the State Route 20 bridge (river mile 24.9). The traps would be checked a minimum of every two hours while operating or more often as needed due to debris and fish movement. The time, water temperature, and trap RPM will be recorded on a daily basis. River discharge for trapping days will be obtained through the Washington State Department of Ecology (DOE) or the USGS Surface Water Monitoring website.

Once the fish have been captured, the researchers would anesthetize them with MS-222, enumerate them and note their species and degree of maturation, allow them to recover in aerated water, and release them. Some of the captured fish would also be measured. Another portion of the captured fish would be marked with a brown die, transported upstream, and released for the purpose of determining the traps' efficiencies. The researchers are requesting the following levels of take:

Table 33. Total Requested Take and Mortalities by Species, Age, Origin, and Action in Permit 16122-3R

Species	Life Stage	Origin	Take Action[a]	Requested Take	Lethal Take	Percent of ESU/DPS taken	Percent of ESU/DPS killed
Upper Columbia River Steelhead	Juvenile	Natural	C/H/R	500	10	0.251	0.005
		Listed Hatchery Intact Adipose	C/H/R	1,200	24	0.866	0.017
		Listed Hatchery Adipose Clip	C/H/R	8,300	166	1.207	0.024

[a] C=Capture, H=Handle, R=Release

Because the majority of the fish that would be captured are expected to recover with no adverse physiological, behavioral, or reproductive effects, the true effects of the proposed action considered herein are best seen in the context of the fish that are likely to be killed. To determine the effects of these losses, it is necessary to compare the numbers of fish that may be killed to the total abundance numbers expected for the population and species—these figures are represented in the last column of the table above.

Thus the research would kill, at most, 0.024% of the outmigration of adipose-fin-clipped hatchery fish (a component of the DPS for which there are no take prohibitions), and smaller amounts of the DPS's other components. However, these small effects would be magnified by the fact that they would all be concentrated on only a portion of the outmigration—the Okanogan River. Given that the Okanogan system produces about one-fourth of the UCR steelhead (of which 9% were natural fish (Ford et al. 2011)), that would signify that the impact that the effects on the Okanogan population would at a maximum approach something on the order of 0.1% mortality for the ad-clipped hatchery smolts coming out of that system and much smaller effects on the populations' other components. (0.02% for the natural component, and 0.07% for the fish with intact adipose fins). These figures thus represent minor effects on abundance at the population level and lesser (or no) effects on productivity (many ad-clipped fish—the ones seeing the biggest impact from the research—are removed from production as adults). There would be no measureable effect on the fishes' structure or diversity at either the population or species level. Moreover, the largest portion of the research's effect on abundance would be on a component of the species that has no take prohibitions and is considered "surplus to recovery needs." In addition, it is worth noting that the last four years' annual reports for this work indicate that in all years, the CCT researchers have taken less than 10% of the fish they were permitted and killed only nine juveniles in total over that time (three natural fish, six adipose-clipped hatchery fish. If that history is any indication of future effect, it is likely that the ongoing work would have far less impact than even the small amount displayed above.

Even if the losses were to be as large as those displayed in the table, an effect of the research that cannot be quantified is the conservation benefit to the species resulting from the research. Permit 16122-3R would allow researchers to estimate natural production and productivity; calculate annual population estimates, egg-to-emigrant survival, and emigrant-to-adult survival rates for fish in the Okanogan system. These population estimates, in turn, would be used to evaluate the effects of supplementation programs in the Okanogan River Basin and provide data to develop a spawner-recruit relationship. These are key pieces of information needed to help guide the species' recovery.

Permit 16290-4R

Under Permit 16290-4R the ODFW would continue to capture, handle, and release juvenile UWR Chinook salmon, UWR steelhead, LCR Chinook salmon, LCR steelhead, LCR coho salmon, and CR chum salmon while conducting research on the Oregon Chub. They have been conducting this work for 10 years and the permit would allow them five more. The researchers would use boat electrofishing equipment, minnow traps, beach seines, dip nets, hoop nets, and fyke nets to capture juvenile fish. They would avoid contact with adult fish at all times. If listed any salmonids are captured during the research, they would be enumerated and released immediately without any further action being taken. The researchers are requesting the following amounts of take.

Table 34. Total Requested Take and Mortalities by Species, Age, Origin, and Action in Permit 16290-4R

Species	Life Stage	Origin	Take Action[a]	Requested Take	Lethal Take	Percent of ESU/DPS taken	Percent of ESU/DPS killed
Lower Columbia River Chinook salmon	Juvenile	Natural	C/H/R	60	2	<0.001	<0.001
		Listed Hatchery Adipose Clip	C/H/R	60	2	<0.001	<0.001
Lower Columbia River coho salmon	Juvenile	Natural	C/H/R	80	2	0.012	<0.001
		Listed Hatchery Adipose Clip	C/H/R	80	2	0.001	<0.001
Lower Columbia River Steelhead	Juvenile	Natural	C/H/R	80	4	0.023	0.001
		Listed Hatchery Adipose Clip	C/H/R	80	4	0.007	<0.001
Columbia River chum salmon	Juvenile	Natural	C/H/R	4	0	<0.001	0.000
Upper Willamette River Chinook salmon	Juvenile	Natural	C/H/R	1,200	24	0.099	0.002
		Listed Hatchery Adipose Clip	C/H/R	1,150	23	0.024	<0.001

Table 34. Total Requested Take and Mortalities by Species, Age, Origin, and Action in Permit 16290-4R

Species	Life Stage	Origin	Take Action[a]	Requested Take	Lethal Take	Percent of ESU/DPS taken	Percent of ESU/DPS killed
Upper Willamette River Steelhead	Juvenile	Natural	C/H/R	330	9	0.235	0.006

[a] C=Capture, H=Handle, R=Release

Because the majority of the fish that would be captured are expected to recover with no adverse physiological, behavioral, or reproductive effects, the true effects of the proposed action considered herein are best seen in the context of the fish that are likely to be killed. To determine the effects of these losses, it is necessary to compare the numbers of fish that may be killed to the total abundance numbers expected for the population and species—these figures are represented in the last column of the table above.

While conducting the permitted activities, the researchers would not encounter any adult fish, but they may unintentionally cause the death of a very small number of juvenile fish. In all cases, the effect of these deaths would be very small. At a maximum, the permitted activities may kill no more than 0.006% of the expected abundance for any of the listed salmon or steelhead. Because the research would take place over such a broad area and in so many different tributaries, the potential losses cannot be ascribed to any population for any species and must therefore be viewed in the context of the listed units as individual wholes. As a result, though the research may in some instances have a very small impact on species abundance and productivity, it would in no measurable way impact structure or diversity for any species. And it is likely that the impacts would be even smaller than those laid out above. For this project over the past five years (2016-2019), the researchers have captured almost no individuals of any listed species and killed none. But even if all the fish that *could* be taken were taken in fact, that effect would be offset to some degree by the data to be gathered—data that managers would use to help restore the habitats upon which both the Oregon chub and listed salmonids depend.

Permit 16417-3M

Under Permit 16417-3M, the Santa Clara Valley Water District would modify and expand upon work they have been conducting that allows them to annually take juvenile and adult CCC steelhead and juvenile SCCC steelhead in the Guadalupe River, Coyote Creek, and Stevens Creek Watershed, Pajaro Watershed, and Lake Almaden in North Santa Clara County, California. In addition to the currently authorized take, the applicants are requesting additional take of juvenile CCC steelhead and juvenile SCCC steelhead. Fish would be captured (using backpack electrofishing, boat electrofishing, and beach seines), handled (weighed, measured, and checked for marks or tags), and released. A subsample of juveniles would be anesthetized, PIT-tagged, and sampled for biological tissues. The purpose of the research is to collect data on steelhead distribution, habitat use, survival rates, and movements. The resulting data would be used to fill knowledge gaps regarding steelhead distribution and relative abundance in Santa Clara County and help better align water district operations and fisheries management.

The researchers are not proposing to kill any fish, but a small number of juveniles may be killed as an inadvertent result of these activities. All mortality will be unintentional and indirect. The amount of take that the Santa Clara Valley Water District is requesting is summarized in the following table.

Table 35. Total Requested Take and Mortalities by Species, Age, Origin, and Action in Permit 16417-3M. Only additional take requested as part of this modification is considered in this opinion.

Species	Life Stage	Origin	Take Action[a]	Requested Take	Lethal Take	Percent of ESU/DPS taken	Percent of ESU/DPS killed
Central California Coast Steelhead	Adult	Natural	C/H/R	0	0	0.000	0.000
		Natural	O/H	0	0	-	-
	Juvenile	Natural	C/H/R	150	5	0.060	0.002
		Natural	C/M, T, ST/R	1,100	34	0.442	0.014
		Natural	O/H	1,500	0	-	-
South-Central California Coast Steelhead	Juvenile	Natural	C/M, T, ST/R	3,200	86	4.048	0.109

[a] C=Capture, H=Handle, R=Release, M=Mark, T=Tag, ST=Sample Tissue, O/H=Observe/Harass

Because the majority of the fish that would be captured are expected to recover with no adverse physiological, behavioral, nor reproductive effects, the true effects of the proposed action considered herein are best seen in the context of the fish that are likely to be killed. To determine the effects of these losses, it is necessary to compare the numbers of fish that may be killed to the total abundance numbers expected for the population and species—these figures are represented in that last column of the table above.

While conducting the permitted activities, the researchers would not kill any adult fish, but they may unintentionally cause the death of a very small number of juvenile fish. In all cases, the effect of these deaths would be very small. At a maximum, the permitted activities may kill no more than 0.109% of the expected abundance of steelhead. Because the research would take place over such a broad area and in so many different tributaries, the potential losses cannot be ascribed to any population for any species and must therefore be viewed in the context of the listed units as individual wholes. As a result, though the research may in some instances have a very small impact on species abundance and productivity, it would in no measurable way impact structure or diversity for any species. And it is likely that the impacts would be even smaller than those laid out above.

Reporting indicates that over the past five years the total take reported for this project was 2.0% of the total amount authorized across all salmonid species. The actual lethal take was also low compared to what was authorized; total lethal take reported was 15.6% of the total lethal take authorized over the past five years. Also, even if the losses were to be as large as those displayed in the table, the effects would to some extent be offset by the information generated from the research, information that managers would use to help the species survive and recover.

Permit 17063-3R

Under permit 17063-3R the U.S. Forest Service would be renewing a permit that currently allows them to take juvenile SONCC coho salmon, NC steelhead, and CC Chinook salmon in the Mad River, Lower Eel River and Eel River drainage, Van Duzen River, and Weaver Creek drainage. Fish would be captured (using backpack electrofishing), handled (anesthetized, weighed, measured, and checked for marks or tags), and released. A subsample of SONCC coho would be PIT-tagged. The purpose of the research is to continue building long-term physical and biological data sets that would be used to develop an individual-based model of anadromous salmonids in Weaver Creek and monitor the distribution of non-native speckled dace in the Mad River and Eel River drainages. The resulting data would be used to assess the effectiveness of habitat restoration projects completed in recent years and study why speckled dace have not expanded their range in the Eel River.

The researchers are not proposing to kill any fish, but a small number of individuals may be killed as an inadvertent result of these activities. The amount of take that the U.S. Forest Service is requesting is summarized in the following table.

Table 36. Total Requested Take and Mortalities by Species, Age, Origin, and Action in Permit 17063-3R

Species	Life Stage	Origin	Take Action[a]	Requested Take	Lethal Take	Percent of ESU/DPS taken	Percent of ESU/DPS killed
Southern Oregon/Northern California Coast coho salmon	Juvenile	Natural	C/H/R	200	3	0.010	<0.001
		Natural	C/M, T, ST/R	150	5	0.007	<0.001
Northern California Steelhead	Juvenile	Natural	C/H/R	750	15	0.091	0.002
California Coastal Chinook salmon	Juvenile	Natural	C/H/R	200	3	0.016	<0.001

[a] C=Capture, H=Handle, R=Release, M=Mark, T=Tag, ST=Sample Tissue

Because the majority of the fish that would be captured are expected to recover with no adverse physiological, behavioral, nor reproductive effects, the true effects of the proposed action considered herein are best seen in the context of the fish that are likely to be killed. To determine the effects of these losses, it is necessary to compare the numbers of fish that may be killed to the total abundance numbers expected for the population and species—these figures are represented in that last column of the table above.

As the table above demonstrates, the overall effect on these species' abundance would in all cases be low impact. To date, no coho or chinook salmon have been observed in the West Weaver Creek study reaches. Though steelhead, coho salmon, and Chinook salmon are known to rear in the Mad River, previous sampling has never encountered a juvenile coho or Chinook salmon. Additionally, no juvenile coho or Chinook salmon have been observed in the monitoring reaches in the Van Duzen River during their previous sampling efforts, although steelhead are commonly observed.

The researchers are not requesting take of any adult fish, but they may unintentionally cause the death of a very small number of juvenile fish. In all cases, the effect of these deaths would be very small. At a maximum, the permitted activities may kill no more than 0.002% of the expected abundance for any of the listed salmon or steelhead. Because the research would take place over such a broad area and in so many different tributaries, the potential losses cannot be ascribed to any population for any species and must therefore be viewed in the context of the listed units as individual wholes. As a result, though the research may in some instances have a very small impact on species abundance and productivity, it would in no measurable way impact structure or diversity for any species.

It is also likely that the impacts would be even smaller than those laid out above. Reporting from this project indicates that over the past five years (2015-2019) the total take was 0.77% of the total amount authorized across all salmonid species, and no lethal take has occurred. Also, even if the losses were to be as large as those displayed in the table, the effects of these losses would to some extent be offset by the information generated from the research, information that managers would use to help the species survive and recover.

Permit 17272-2R

Under permit 17272-2R the U.S. Fish and Wildlife Service would be renewing a permit that currently allows them to annually take juvenile and adult SONCC coho salmon in the Klamath River Basin. Adult fish would be observed during spawning surveys, and tissue samples would be collected from spawned adult carcasses. Juvenile fish would be captured (using rotary screw traps, fyke traps, and beach seines), handled (weighed, measured, and checked for marks or tags), and released. The purpose of the research is to assess population status, health, habitat use, and mechanisms influencing disease in fish populations of the Klamath River Basin. The resulting data would be used to help managers understand the effects of flow and temperature conditions and timing on disease, the importance of specific habitats to aquatic species, the response of aquatic habitats to restoration actions, and how aquatic habitat is affected by human interaction.

The researchers are not proposing to kill any fish, but a small number of juvenile fish may be killed as an inadvertent result of these activities. The amount of take that the U.S. Fish and Wildlife Service is requesting is summarized in the following table.

Table 37. Total Requested Take and Mortalities by Species, Age, Origin, and Action in Permit 17272-2R

Species	Life Stage	Origin	Take Action[a]	Requested Take	Lethal Take	Percent of ESU/DPS taken	Percent of ESU/DPS killed
Southern Oregon/Northern California Coast coho salmon	Adult	Natural	O/H	120	0	-	-
		Listed Hatchery Intact Adipose	O/H	120	0	-	-
	Spawned Adult/ Carcass	Natural	O/ST D	120	0	-	-
		Listed Hatchery Intact Adipose	O/ST D	120	0		
	Juvenile	Natural	C/H/R	14,500	145	0.720	0.007
		Listed Hatchery Intact Adipose	C/H/R	3,300	33	0.574	0.006
		Listed Hatchery Adipose Clip	C/H/R	2,400	24	1.200	0.012

[a] C=Capture, H=Handle, R=Release, ST=Sample Tissue, O/H=Observe/Harass, D=Dead Animal

Because the majority of the fish that would be captured are expected to recover with no adverse physiological, behavioral, nor reproductive effects, the true effects of the proposed action considered herein are best seen in the context of the fish that are likely to be killed. To determine the effects of these losses, it is necessary to compare the numbers of fish that may be killed to the total abundance numbers expected for the population and species—these figures are represented in that last column of the table above.

While conducting the permitted activities, the researchers would not handle any adult fish, but they may unintentionally cause the death of a very small number of juvenile fish. In all cases, the effect of these deaths would be very small. At a maximum, the permitted activities may kill no more than 0.012% of the expected abundance for juvenile SONCC coho salmon. Because the research would take place over such a broad area and in so many different tributaries, the potential losses cannot be ascribed to any population for any species and must therefore be viewed in the context of the listed units as individual wholes. As a result, though the research may in some instances have a very small impact on species abundance and productivity, it would in no measurable way impact structure or diversity for any species.

It is also likely that the impacts would be even smaller than those laid out above. Reporting indicates that over the past five years the total take reported for this project was 6.2% of the total amount authorized across all salmonid species. The actual lethal take was also low compared to what was authorized; total lethal take reported was 26.1% of the total lethal take authorized over the past five years. Even if the losses were to be as large as those displayed in the table, the effects would to some extent be offset by the information generated from the research, information that managers would use to help the species survive and recover.

Permit 17867-2R

Under permit 17867-2R the Humboldt Redwood Company (HRC) would be renewing a permit that currently allows them to take juvenile and adult SONCC coho salmon, NC steelhead, and CCC Chinook salmon in within the Mad-Redwood basin, Lower Eel basin, and Mattole basin in Humboldt County, California. Adult and juvenile fish would be observed via snorkel survey, and a subset of juvenile SONCC coho and NC steelhead would be captured (using backpack electrofishing), handled (weighed, measured, and checked for marks or tags), and released. The purpose of the research is to determine the occurrence, distribution, population abundance, and habitat conditions of listed salmonids on HRC lands. The resulting data would be used to monitor, protect, restore and enhance the anadromous fishery resources in watersheds owned by HRC.

The researchers are not proposing to kill any fish, but a small number of juvenile fish may be killed as an inadvertent result of these activities. The amount of take that the HRC is requesting is summarized in the following table.

Table 38. Total Requested Take and Mortalities by Species, Age, Origin, and Action in Permit 17867-2R

Species	Life Stage	Origin	Take Action[a]	Requested Take	Lethal Take	Percent of ESU/DPS taken	Percent of ESU/DPS killed
Southern Oregon/Northern California Coast coho salmon	Adult	Natural	O/H	30	0	-	-
	Juvenile	Natural	C/H/R	25	1	0.001	<0.001
		Natural	O/H	5,005	0	-	-
Northern California Steelhead	Adult	Natural	O/H	30	0	-	-
	Juvenile	Natural	C/H/R	300	6	0.037	<0.001
		Natural	O/H	8,000	0	-	-
California Coastal Chinook salmon	Adult	Natural	O/H	30	0	-	-
	Juvenile	Natural	O/H	1,105	0	-	-

[a] C=Capture, H=Handle, R=Release, O/H=Observe/Harass

Because the majority of the fish that would be captured are expected to recover with no adverse physiological, behavioral, nor reproductive effects, the true effects of the proposed action considered herein are best seen in the context of the fish that are likely to be killed. To determine the effects of these losses, it is necessary to compare the numbers of fish that may be killed to the total abundance numbers expected for the population and species—these figures are represented in that last column of the table above.

While conducting the permitted activities, the researchers would only observe adult fish, but they may unintentionally cause the death of a very small number of handled juvenile fish. In all cases, the effect of these deaths would be very small. At a maximum, the permitted activities may kill no more than 0.001% of the expected abundance for any of the listed salmon or steelhead. Because the research would take place over such a broad area and in so many different tributaries, the potential losses cannot be ascribed to any population for any species and must therefore be viewed in the context of the listed units as individual wholes. As a result, though the research may in some instances have a very small impact on species abundance and productivity, it would in no measurable way impact structure or diversity for any species.

It is also likely that the impacts would be even smaller than those laid out above. Reporting for this project indicates that over the past five years (2015-2019) the total take reported was 0.54% of the total amount authorized across all salmonid species, and no lethal take was reported. Even if the losses were to be as large as those displayed in the table, the effects would to some extent be offset by the information generated from the research, information that managers would use to help the species survive and recover.

Permit 18921-2R

Under permit 18921-2R, the SINDNR would be renewing for five years a permit that currently allows them to annually take listed juvenile PS Chinook salmon and PS steelhead in the marine waters immediately adjacent to Cypress Island (of the San Juan Island archipelago) in Secret Harbor (Skagit County, WA). The SINDNR research may also cause them to take adult S eulachon, for which there are currently no ESA take prohibitions. Using beach seines, listed fish would be captured, identified to species, measured, and released. The researchers do not propose to kill any of the listed fish being captured, but a small number may die as an unintended result of the activities. The amount of take the SINDNR is requesting is found in the following table.

Table 39. Total Requested Take and Mortalities by Species, Age, Origin, and Action in Permit 18921-2R

Species	Life Stage	Origin	Take Action[a]	Requested Take	Lethal Take	Percent of ESU/DPS taken	Percent of ESU/DPS killed
Puget Sound Chinook salmon	Juvenile	Natural	C/H/R	200	2	0.006	<0.001
		Listed Hatchery Adipose Clip	C/H/R	100	1	<0.001	<0.001
Puget Sound Steelhead	Juvenile	Natural	C/H/R	10	1	<0.001	<0.001

Table 39. Total Requested Take and Mortalities by Species, Age, Origin, and Action in Permit 18921-2R

Species	Life Stage	Origin	Take Action[a]	Requested Take	Lethal Take	Percent of ESU/DPS taken	Percent of ESU/DPS killed
Southern DPS Eulachon	Adult	Natural	C/H/R	4	1	<0.001	<0.001

[a] C=Capture, H=Handle, R=Release

Because the majority of the fish that would be captured are expected to recover with no adverse physiological, behavioral, or reproductive effects, the true effects of the proposed action considered herein are best seen in the context of the fish that are likely to be killed. To determine the effects of these losses, it is necessary to compare the numbers of fish that may be killed to the total abundance numbers expected for the population and species—these figures are represented in the last column of the table above.

Due to the marine location of the research activities, impacts cannot be examined at the population level since any outmigrating population may be present. At the ESU/DPS level, the permitted activities may kill—at most—less than 0.001% for any listed species component. This research, therefore, would have a very small impact on the species' abundance, a likely similar impact on their productivity, and no measurable effect on their spatial structure or diversity. And it is possible that the impacts could be even smaller than those laid out above. For this project over the past five years (2015-2019), the researchers have taken none of their total request (0 of 1,570 fish) and none of their requested mortalities (0 of 25 fish). As a result, the research could very well have no adverse effects at all.

An effect of the research that cannot be quantified is the conservation benefit to the species resulting from the research. The purpose of the study is to determine fish presence both within and around the Secret Harbor estuary restoration site to continue studying the effectiveness of the restoration efforts. Even if the losses were to be as large as those displayed in the table, this research would benefit the affected species by informing future restoration designs and providing data to support future enhancement projects.

Permit 18937-3R

Under permit 18937-3R, the Scripps Institute of Oceanography would be renewing a permit that currently allows them to take juvenile and adult CC Chinook salmon, CCC coho salmon, and CCC steelhead in the Russian River watershed. Adult fish would be observed via snorkel surveys or spawning surveys, and tissue samples would be collected from carcasses found during spawning surveys. If any adults were to be unintentionally captured in juvenile sampling gear, they would immediately be released. Juvenile fish would also be observed via snorkel surveys and a subset would be captured (using backpack electrofishing, hand- or dip-nets, funnel/pipe traps, and minnow traps), handled (anesthetized, weighed, measured, and checked for marks or tags), and released. A subsample would be anesthetized and PIT-tagged, have tissue samples taken, or have stomach contents sampled (non-lethally). The purpose of the research is to estimate salmonid population metrics such as abundance, survival, growth, and spatial distribution of multiple life stages in the Russian River watershed. The resulting data would be used to provide resource agencies with information relating to population metrics and thereby help them plan recovery actions such as hatchery releases, habitat enhancement projects, and stream flow improvement projects.

The researchers are not proposing to kill any fish, but a small number of juveniles and post-spawn steelhead (kelts) may be killed as an inadvertent result of these activities. The amount of take that the Scripps Institute of Oceanography is requesting is summarized in the following table.

Table 40. Total Requested Take and Mortalities by Species, Age, Origin, and Action in Permit 18937-3R

Species	Life Stage	Origin	Take Action[a]	Requested Take	Lethal Take	Percent of ESU/DPS taken	Percent of ESU/DPS killed
California Coastal Chinook salmon	Adult	Natural	O/H	460	0	-	-
	Spawned Adult/ Carcass	Natural	O/ST D	130	0	-	-
	Juvenile	Natural	C/H/R	500	10	0.039	<0.001
		Natural	O/H	1,000	0	-	-
Central California Coast coho salmon	Adult	Natural	O/H	320	0	-	-
		Listed Hatchery Intact Adipose	C/H/R	10	0	3.058	0.000
		Listed Hatchery Intact Adipose	O/H	340	0	-	-
	Spawned Adult/ Carcass	Natural	O/ST D	155	0	-	-
		Listed Hatchery Intact Adipose	O/ST D	160	0		
	Juvenile	Natural	O/H	22,000	0	-	-
		Natural	C/H/R	10,100	202	6.387	0.128
		Natural	C/M, T, ST/R	9,300	186	5.881	0.118
		Listed Hatchery Intact Adipose	C/M, T, ST/R	3,000	60	1.809	0.036
		Listed Hatchery Intact Adipose	C/H/R	19,500	390	11.755	0.235
		Listed Hatchery Intact Adipose	O/H	30,000	0	-	-

Table 40. Total Requested Take and Mortalities by Species, Age, Origin, and Action in Permit 18937-3R

Species	Life Stage	Origin	Take Action[a]	Requested Take	Lethal Take	Percent of ESU/DPS taken	Percent of ESU/DPS killed
Central California Coast Steelhead	Adult	Natural	O/H	1,600	0	-	-
		Listed Hatchery Adipose Clip	O/H	450	0	-	-
	Spawned Adult/ Carcass	Natural	O/ST D	150	0	-	-
		Natural	C/H/R	50	1		
		Listed Hatchery Adipose Clip	C/H/R	100	2		
		Listed Hatchery Adipose Clip	O/ST D	150	0		
	Juvenile	Natural	O/H	94,000	0	-	-
		Natural	C/H/R	18,200	364	7.316	0.146
		Natural	C/M, T, ST/R	8,700	174	3.497	0.070
		Listed Hatchery Adipose Clip	C/H/R	100	2	0.015	<0.001

[a] C=Capture, H=Handle, R=Release, M=Mark, T=Tag, ST=Sample Tissue, D=Dead Animal, O=Observe, H=Harass

Because the majority of the fish that would be captured are expected to recover with no adverse physiological, behavioral, nor reproductive effects, the true effects of the proposed action considered herein are best seen in the context of the fish that are likely to be killed. To determine the effects of these losses, it is necessary to compare the numbers of fish that may be killed to the total abundance numbers expected for the population and species—these figures are represented in that last column of the table above.

While conducting the permitted activities, the researchers would not kill any adult fish, but they may unintentionally cause the death of a very small number of juvenile fish. In all cases, the effect of these deaths would be very small. At a maximum, the permitted activities may kill no more than 0.146% of the expected abundance for any of the listed salmon or steelhead. Because the research would take place over such a broad area and in so many different tributaries, the potential losses cannot be ascribed to any population for any species and must therefore be viewed in the context of the listed units as individual wholes. As a result, though the research may in some instances have a very small impact on species abundance and productivity, it would in no measurable way impact structure or diversity for any species.

It is also likely that the impacts would be even smaller than those laid out above. Reporting from this project indicates that over the past five years (2015-2019) the total take reported was 15.8% of the total amount authorized across all salmonid species. The actual lethal take was also low compared to what was authorized: total lethal take reported was 3.6% of the total lethal take authorized over the past five years. Even if the losses were to be as large as those displayed in the table, the effects would to some extent be offset by the information generated from the research, information that managers would use to help the species survive and recover.

Permit 19121-2R

Under permit 19121-2R, the U.S. Geological Survey would be renewing a permit that allows them to take juvenile and adult SacR WR Chinook salmon, CVS Chinook salmon, CVS steelhead, and adult sDPS green sturgeon in the San Francisco estuary and Sacramento-San Joaquin Delta. Salmonids would be captured (using boat electrofishing, fyke nets, gill nets, zooplankton nets, midwater trawls, otter trawls, and beach seines), handled (weighed, measured, and checked for marks or tags), and released. Any green sturgeon adults captured as a result of longline sampling would be anesthetized, PIT-tagged, and would be sampled for biological tissues prior to release. The purpose of this research is to study how physical and biological factors relate to fish assemblages and populations—particularly with regard to the distribution of delta smelt in tidal wetlands in the San Francisco estuary and delta. The resulting data would be used to address potential benefits of habitat restoration, specifically by identifying habitat characteristics in restored sites that are associated with plankton production sufficient to establish a food web supporting native fish populations. The data would also help researchers develop new research tools for studying delta smelt.

The researchers are not proposing to kill any ESA-listed fish, but a small number of adult and juvenile fish may be killed as an inadvertent result of these activities. In addition, a small number of juvenile non-ESA listed (*i.e.*, fall-run) Chinook salmon would also be intentionally sacrificed for stomach contents analysis, and a small number of juvenile CVS spring-run Chinook salmon may be killed as part of this effort in the unlikely event that they are misidentified. The amount of take that the U.S. Geological Survey is requesting is summarized in the following table.

Table 41. Total Requested Take and Mortalities by Species, Age, Origin, and Action in Permit 19121-2R

Species	Life Stage	Origin	Take Action[a]	Requested Take	Lethal Take	Percent of ESU/DPS taken	Percent of ESU/DPS killed
Sacramento River winter-run Chinook salmon	Adult	Natural	C/H/R	10	0	4.762	0.000
		Listed Hatchery Adipose Clip	C/H/R	10	0	0.448	0.000
	Juvenile	Natural	C/H/R	151	2	0.077	0.001
		Listed Hatchery Adipose Clip	C/H/R	151	2	0.075	0.001
	Adult	Natural	C/H/R	20	1	0.537	0.027

Table 41. Total Requested Take and Mortalities by Species, Age, Origin, and Action in Permit 19121-2R

Species	Life Stage	Origin	Take Action[a]	Requested Take	Lethal Take	Percent of ESU/DPS taken	Percent of ESU/DPS killed
Central Valley spring-run Chinook salmon		Listed Hatchery Adipose Clip	C/H/R	20	1	0.880	0.044
	Juvenile	Natural	C/H/R	1,421	26	0.183	0.003
		Natural	IM	3	3	<0.001	<0.001
		Listed Hatchery Adipose Clip	C/H/R	1,421	26	0.066	0.001
California Central Valley Steelhead	Adult	Natural	C/H/R	20	1	1.186	0.059
		Listed Hatchery Adipose Clip	C/H/R	20	1	0.519	0.026
	Juvenile	Natural	C/H/R	95	2	0.015	<0.001
		Listed Hatchery Adipose Clip	C/H/R	400	10	0.025	<0.001
Southern DPS green sturgeon	Adult	Natural	C/M, T, ST/R	2	2	0.095	0.095
	Juvenile	Natural	C/M, T, ST/R	2	2	0.046	0.046

[a] C=Capture, H=Handle, R=Release, M=Mark, T=Tag, ST=Sample Tissue, IM=Intentional Mortality

Because the majority of the fish that would be captured are expected to recover with no adverse physiological, behavioral, nor reproductive effects, the true effects of the proposed action considered herein are best seen in the context of the fish that are likely to be killed. To determine the effects of these losses, it is necessary to compare the numbers of fish that may be killed to the total abundance numbers expected for the population and species—these figures are represented in that last column of the table above.

While conducting the permitted activities, the researchers may unintentionally cause the death of a very small number of adult and juvenile fish. In all cases, the effect of these deaths would be very small. At a maximum, the permitted activities may kill no more than 0.095% of the expected abundance for any of the listed species. Because the research would take place over such a broad area and in so many different tributaries, particularly in lower river reaches in the deltas and San Francisco Estuary, the potential losses cannot be ascribed to any population for any species and must therefore be viewed in the context of the listed units as individual wholes. As a result, though the research may in some instances have a very small impact on species abundance and productivity, it would in no measurable way impact structure or diversity for any species.

It is also likely that the impacts would be even smaller than those laid out above. Reporting from this project indicates that over the past five years (2015-2019) the total take reported was 0.29% of the total amount authorized across all salmonid species. The actual lethal take was also low compared to what was authorized; total lethal take reported was 0.7% of the total lethal take authorized over the past five years. Even if the losses were to be as large as those displayed in the table, the effects would to some extent be offset by the information generated from the research, information that managers would use to help the species survive and recover.

Permit 23649

Permit 23649 would allow Mt. Hood Environmental to take juvenile MCR steelhead in the one-mile reach below Bowman Dam on the Crooked River in Oregon. The researchers would use single-pass backpack electrofishing units and a screw trap near the dam's outlet to capture the fish. Once captured, the fish would be individually identified to species, measured, weighed, and their condition noted. They would then be released back to the river near the site of their capture. NMFS's electrofishing guidelines would be followed at all times. The screw trapping operation would continue for three to four one-month periods to capture seasonal variability. In each instance, the trap would be checked daily and the fish would undergo the same procedures as those described for the electrofishing effort. The researchers are requesting the following levels of take:

Table 42. Total Requested Take and Mortalities by Species, Age, Origin, and Action in Permit 23649

Species	Life Stage	Origin	Take Action[a]	Requested Take	Lethal Take	Percent of ESU/DPS taken	Percent of ESU/DPS killed
Middle Columbia River Steelhead	Juvenile	Natural	C/H/R	600	18	0.147	0.004
		Listed Hatchery Intact Adipose	C/H/R	600	18	0.543	0.016

[a] C=Capture, H=Handle, R=Release

Because the majority of the fish that would be captured are expected to recover with no adverse physiological, behavioral, or reproductive effects, the true effects of the proposed action considered herein are best seen in the context of the fish that are likely to be killed. To determine the effects of these losses, it is necessary to compare the numbers of fish that may be killed to the total abundance numbers expected for the population and species—these figures are represented in the last column of the table above.

As the table illustrates, the research would have, at most a very small effect on any component of the MCR steelhead DPS. However, to understand what those figures actually mean, two things must be take into consideration: First, the effect would be localized to only those fish produced in the Deschutes River. While we do not know how many fish this population group produces, it would be conservative to say that at least 10% of the natural fish in the DPS come from there, and some larger percentage of the intact-adipose hatchery fish. That would mean that at the local level, the research may kill as much as 0.04% of the natural fish and something approaching 0.2% of the intact-adipose hatchery-origin fish. In both cases, these are very small effects at the local level and nearly unmeasurable at the level of the listed unit.

Second, and as noted above, all of the fish would actually be coming from the Deschutes River NEP—an experimental population that is considered, in its entirety, to be excess to the MCR steelhead's recovery needs. As a result, the loss of so few juvenile fish is unlikely to have a measurable impact on even the species' abundance and productivity—let alone structure or diversity. But even that nearly inconsequential loss would be offset to some degree by the data to be gained from the research, data that would be sued in the future to operate Bowman Dam in as fish-friendly a manner as possible.

Permit 23843

As noted previously, issuing permit 23843 would authorize the SRSC to take juvenile PS Chinook salmon and PS steelhead in the Skagit River floodplain between river miles 54 and 79 (Skagit County, WA). The SRSC proposes to capture fish using fence-weir smolt traps and backpack and boat electrofishing equipment. Fish would be captured, identified to species, measured, fin clipped (caudal fin), dyed, and released. Observational methods such as snorkel and redd surveys would be used to inform and supplement the above methods. The researchers do not propose to kill any of the listed fish being captured, but a small number may die as an unintended result of the activities. The amount of take the SRSC is requesting is found in the following tables.

Table 43. Total Requested Take and Mortalities by Species, Age, Origin, and Action in Permit 23843

Species	Life Stage	Origin	Take Action[a]	Requested Take	Lethal Take	Percent of ESU/DPS taken	Percent of ESU/DPS killed
Puget Sound Chinook salmon	Juvenile	Natural	C/H/R	800	24	0.025	<0.001
		Natural	C/M, T, ST/R	3,000	30	0.095	<0.001
		Listed Hatchery Intact Adipose	C/H/R	100	2	0.001	<0.001
		Listed Hatchery Adipose Clip	C/H/R	100	2	<0.001	<0.001
Puget Sound Steelhead	Juvenile	Natural	C/H/R	800	24	0.036	0.001
		Natural	C/M, T, ST/R	3,000	30	0.136	0.001

[a] C=Capture, H=Handle, R=Release, M=Mark, T=Tag, ST=Sample Tissue

Because the majority of the fish that would be captured are expected to recover with no adverse physiological, behavioral, or reproductive effects, the true effects of the proposed action considered herein are best seen in the context of the fish that are likely to be killed. To determine the effects of these losses, it is necessary to compare the numbers of fish that may be killed to the total abundance numbers expected for the population and species—these figures are represented in the last column of the table above and below.

Table 44. Proposed take and comparison of possible lethal take to annual abundance at the population (natural-origin) and watershed (hatchery produced) scale under permit 23843.

Species	Life Stage	Origin	Requested Take	Lethal Take	Percent of Population taken	Percent of Population killed
Puget Sound Chinook salmon	Juvenile	Listed Hatchery Adipose Clip	100	2	0.017%	<0.001%
		Listed Hatchery Intact Adipose	100	2	0.050%	0.001%
		Natural[a]	3,800	54	0.315%	0.004%
Puget Sound Steelhead	Juvenile	Natural[b]	3,800	54	0.444%	0.006%

[a] Upper Skagit River, Lower Skagit River, Upper Sauk River, Lower Sauk River, Suiattle River, and Cascade River populations combined; abundance is estimated at 587,500 Listed Hatchery Adipose Clip, 200,000 Listed Hatchery Intact Adipose (WDFW 2020), and 1,207,748 naturally produced individuals.
[b] Skagit River population; abundance is estimated at 856,175 naturally produced individuals.

At the population level, the permitted activities may kill at most 0.006% of natural-origin juvenile PS steelhead and 0.004% of natural-origin PS Chinook salmon with both hatchery-produced PS Chinook salmon components killed at no more than 0.001%. At the ESU/DPS levels, the permitted activities may kill at most 0.001% of any ESA-listed component. Therefore, the research would have a very small impact on the species' abundance, a likely similar impact on their productivity, and no measurable effect on their spatial structure or diversity. And it is possible that the impacts could be even smaller than those laid out above. Over the past five years (2015-2019) our reporting shows that researchers have only taken 27-29% of the PS juvenile Chinook salmon or steelhead they were authorized to handle, and killed only 16-23% of the total permitted juvenile mortalities allotted for either species.

An effect of the research that cannot be quantified is the conservation benefit to the species resulting from the research. The purpose of the study is to evaluate a restoration action designed to reconnect 1,700 acres of Skagit River floodplain (Barnaby Slough) by monitoring its effect upon salmonid densities and productivity. Barnaby Slough was used as a rearing pond for hatchery steelhead by the Washington Department of Fish and Wildlife from the 1960's until 2007 and includes three dams, numerous dikes, and a smaller enclosed rearing pond. These features modify flow conditions and block fish passage to the slough and are slated for removal and restoration. Even if the losses were to be as large as those displayed in the table, this research would benefit the affected species by informing future restoration designs as well as providing impetus for future enhancement projects.

2.6 Cumulative Effects

"Cumulative effects" are those effects of future state or private activities, not involving Federal activities, that are reasonably certain to occur within the action area of the Federal action subject to consultation (50 CFR 402.02 and 402.17(a)). Future Federal actions that are unrelated to the proposed action are not considered in this section because they require separate consultation pursuant to section 7 of the ESA.

Because the action area falls entirely within designated critical habitat and navigable marine waters, the vast majority of future actions in the region will undergo section 7 consultation with one or more of the Federal entities with regulatory jurisdiction over water quality, habitat management, flood management, navigation, or hydroelectric generation. In almost all instances, proponents of future actions will need government funding or authorization to carry out a project that may affect any of the species discussed in this opinion or their habitat, and therefore the effects such a project may have on listed species will be analyzed when the need arises.

Some continuing non-Federal activities are reasonably certain to contribute to climate effects within the action area. However, it is difficult if not impossible to distinguish between the action area's future environmental conditions caused by global climate change that are properly part of the species status/environmental baseline vs. cumulative effects. Therefore, all relevant future climate-related environmental conditions in the action area are described in the status section (Section 2.2).

In developing this biological opinion, we considered several efforts being made at the local, tribal, state, and national levels to conserve listed species—primarily final recovery plans and efforts laid out in the Status review updates for Pacific salmon and steelhead listed under the Endangered Species Act.[2] The recovery plans, status summaries, and limiting factors that are part of the analysis of this Opinion are discussed in detail in Table 2 (Section 2.2.1).

The result of that review was that salmon take—particularly take associated with monitoring and habitat restoration—is likely to continue to increase in the region for the foreseeable future. However, as noted above, all actions falling in those categories would also have to undergo consultation (like that in this opinion) before they are allowed to proceed.

Future state, tribal, and local government actions will likely be in the form of legislation, administrative rules, or policy initiatives. Government and private actions may include changes in land and water uses, including ownership and intensity, any of which could impact listed species or their habitat. Government actions are subject to political, legislative, and fiscal uncertainties. These realities, added to the geographic scope of the action area, which encompasses numerous government entities exercising various authorities, make any analysis of cumulative effects difficult and speculative. For more information on the various efforts being made at the local, tribal, state, and national levels to conserve PS Chinook salmon and other listed salmonids, see any of the recent

[2] NOAA Fisheries – West Coast Region - 2016 Status Reviews of Listed Salmon & Steelhead

status reviews, listing Federal Register notices, and recovery planning documents, as well as recent consultations on issuance of section 10(a)(1)(A) research permits.

Thus, non-Federal activities are likely to continue affecting listed species and habitat within the action area. These cumulative effects in the action area are difficult to analyze because of this opinion’s large geographic scope, the different resource authorities in the action area, the uncertainties associated with government and private actions, and the changing economies of the region. Whether these effects will increase or decrease is a matter of speculation; however, it seems likely that they will continue to increase as a general pattern over time. The primary cumulative effects will arise from those water quality and quantity impacts that occur as human population growth and development shift patterns of water and land use, thereby creating more intense pressure on streams and rivers within this geography in terms of volume, velocities, pollutants, baseflows, and peak flows. But the specifics of these effects, too, are impossible to predict at this time. In addition, there are the aforementioned effects of climate change—many of those will arise from or be exacerbated by actions taking place in the Pacific Northwest and elsewhere that will not undergo ESA consultation. Although many state, tribal, and local governments have developed plans and initiatives to benefit listed fish, they must be applied and sustained in a comprehensive way before NMFS can consider them “reasonably foreseeable” in its analysis of cumulative effects.

We can, however, make some generalizations based on population trends.

Puget Sound/Western Washington

Non-Federal actions are likely to continue affecting listed species. The cumulative effects in this portion of the action area are difficult to analyze because of this opinion’s geographic scope, however, based on the trends identified in the baseline, the adverse cumulative effects are likely to increase. From 1960 through 2016, the population in Puget Sound has increased from 1.77 to 4.86 million people (Source: WA state Office of Financial Management homepage). During this population boom, urban land development has eliminated hydrologically mature forest and undisturbed soils resulting in significant change to stream channels (altered stream flow patterns, channel erosion) which eventually results in habitat simplification (Booth et al. 2002). Combining this population growth with over a century of resource extraction (logging, mining, etc.), Puget Sound’s hydrology has been greatly changed and has created a different environment than what Puget Sound salmonids evolved in (Cuo et al. 2009). Scholz et al. (2011) has documented adult coho salmon mortality rates of 60-100% for the past decade in urban central Puget Sound streams that are high in metals and petroleum hydrocarbons especially after stormwater runoff. In addition, marine water quality factors (e.g. climate change, pollution) are likely to continue to be degraded by various human activities that will not undergo consultation. Although state, tribal, and local governments have developed plans and initiatives to benefit listed fish, they must be applied and sustained in a comprehensive way before NMFS can consider them “reasonably foreseeable” in its analysis of cumulative effects. Thus, the most likely cumulative effect is that the habitat in the action area is likely to continue to be degraded with respect to its ability to support the listed salmonids.

Idaho and Eastern Oregon and Washington

According to the U.S. Census bureau, the State of Idaho's population has been increasing at about 1% per year over the last several years, but that increase has largely been confined to the State's urban areas. The rural population—the areas where the proposed actions would take place--saw a 14% decrease in population between 1990 and 2012.[3] This signifies that in the action areas, if this trend continues, there is likely to be a reduction in competing demands for resources such as water. Also, it is likely that streamside development will decrease. However, given the overall increase in population, recreation demand for resources such as the fish themselves may go up—albeit slowly.

The situation is similar for Eastern Oregon and Washington. Both states have seen population increases between 0.5% and 1.5% per year for Oregon between 2000 and 2010,[4] an overall 12% for Washington between 2000 and 2010, and a 2.7% increase for rural, eastern Oregon for the past five years (2013-2018).[5] And, though Eastern Washington has also seen some population increase, it has largely been restricted to the population centers rather than the rural areas.[6] This signifies that, as with Idaho, there is little likelihood that there will be increasing competing demands for primary resources like water, but recreational demand for the species themselves will probably increase along with the human population.

Western Oregon

The situation in Western Oregon is likely to be similar to that of the Puget Sound region: cumulative effects are likely to continue increasing both in the Willamette valley and along the coast, with nearly all counties showing year-by-year population increases of about 0.5% to 1.5% over the last several years.[6] The result of this growth is that there will be more development and therefore more habitat impacts such as simplification, hydrologic effects, greater levels of pollution (in the Willamette Valley), other water quality impacts, soil disturbance, etc. These effects would be somewhat lessened in the coastal communities, but resource extraction (particularly timber harvest) would probably continue to increase slightly. Though once again, most such activities, whether associated with development or extraction, would undergo formal consultation if they were shown to take place in (or affect) critical habitat or affect listed species. So, it is difficult to characterize the effects that would not be consulted upon beyond saying they are likely to increase both in severity and geographic scope.

California

According to the U.S. Census Bureau, the State of California's population increased 6.1% from 2010 to 2019 (source: Census Bureau California Quick Facts). If this trend in population growth

[3] Idaho State Journal June 2, 2013 "Idaho's rural population continues to shrink"
[4] Portland State University "Annual Oregon Population Report"
[5] State of Oregon Employment Department Dec 20, 2018 "A Quick Look at Population Trends in Eastern Oregon"
[6] Cashmere Valley Record March 9, 2011 "Population growth slowed during last decade, but state is more diversified"

continues, there will be an increase in competing demands for water resources. Water withdrawals, diversions, and other hydrological modifications to regulate water bodies are likely to continue. Urbanization and rural development are limiting factors for many of the listed salmonids within the State of California and these factors are likely to increase with continued population growth. Therefore, the most likely cumulative effect is that the habitat in the action area is likely to continue to be degraded with respect to its ability to support the listed salmonids.

One final thing to take into account when considering cumulative effects is the time period over which the activity would operate. The permits considered here would be good for a maximum of five years and the effects on listed species abundance they generate could continue for up to four years after that, though they would decrease in each succeeding year. We are unaware of any major non-Federal activity that could affect listed salmonids and is certain to occur in the action area during that timeframe.

2.7 Integration and Synthesis

The Integration and Synthesis section is the final step in our assessment of the risk posed to species and critical habitat as a result of implementing the proposed action. In this section, we add the effects of the action (Section 2.5) to the environmental baseline (Section 2.4) and the cumulative effects (Section 2.6), taking into account the status of the species and critical habitat (Section 2.2), to formulate the agency's biological opinion as to whether the proposed action is likely to: (1) Reduce appreciably the likelihood of both the survival and recovery of a listed species in the wild by reducing its numbers, reproduction, or distribution; or (2) appreciably diminish the value of designated or proposed critical habitat as a whole for the conservation of the species.

Aside from the considerations listed above, these assessments are also made in consideration of the other research that has been authorized and that may affect the various listed species. The reasons we integrate the proposed take in the permits considered here with the take from previous (but ongoing) research authorizations are that they are similar in nature and we have good information on what the effects are, and thus it is possible to determine the overall effect of all research in the region on the species considered here. The following two tables therefore (a) combine the proposed take for all the permits considered in this opinion for all components of each species (Table 45), (b) add that take to the take that has already been authorized in the region and (c) compare those totals to the estimated annual abundance of each species under consideration (Table 46).

Table 45. Total requested take for the permits and percentages of the ESA listed species for permits covered in this Biological Opinion

Species	Life Stage	Origin	Requested Take	Lethal Take	Percent of ESU/DPS taken	Percent of ESU/DPS killed
	Juvenile	Natural	4,020	57	0.127	0.002

Table 45. Total requested take for the permits and percentages of the ESA listed species for permits covered in this Biological Opinion

Species	Life Stage	Origin	Requested Take	Lethal Take	Percent of ESU/DPS taken	Percent of ESU/DPS killed
Puget Sound Chinook salmon		Listed Hatchery Intact Adipose	100	2	0.001	<0.001
		Listed Hatchery Adipose Clip	200	3	<0.001	<0.001
Puget Sound Steelhead	Juvenile	Natural	3,835	56	0.174	0.003
Upper Columbia River Steelhead	Juvenile	Natural	500	10	0.251	0.005
		Listed Hatchery Intact Adipose	1,200	24	0.866	0.017
		Listed Hatchery Adipose Clip	8,300	166	1.207	0.024
Middle Columbia River Steelhead	Juvenile	Natural	600	18	0.147	0.004
		Listed Hatchery Intact Adipose	600	18	0.543	0.016
Lower Columbia River Chinook salmon	Juvenile	Natural	85	7	<0.001	<0.001
		Listed Hatchery Adipose Clip	60	2	<0.001	<0.001
Lower Columbia River coho salmon	Juvenile	Natural	130	7	0.020	0.001
		Listed Hatchery Adipose Clip	80	2	0.001	<0.001
Lower Columbia River Steelhead	Juvenile	Natural	130	8	0.037	0.002
		Listed Hatchery Adipose Clip	80	4	0.007	<0.001
Columbia River chum salmon	Juvenile	Natural	24	2	<0.001	<0.001
Upper Willamette River Chinook salmon	Juvenile	Natural	1,225	27	0.101	0.002
		Listed Hatchery Adipose Clip	1,150	23	0.024	<0.001
Upper Willamette River Steelhead	Juvenile	Natural	380	11	0.271	0.008
Southern Oregon/Northern	Juvenile	Natural	14,875	154	0.739	0.008
		Listed Hatchery Intact Adipose	3,300	33	0.574	0.006

Table 45. Total requested take for the permits and percentages of the ESA listed species for permits covered in this Biological Opinion

Species	Life Stage	Origin	Requested Take	Lethal Take	Percent of ESU/DPS taken	Percent of ESU/DPS killed
California Coast coho salmon		Listed Hatchery Adipose Clip	2,400	24	1.200	0.012
Northern California Steelhead	Juvenile	Natural	1,050	21	0.128	0.003
California Coastal Chinook salmon	Juvenile	Natural	700	13	0.055	0.001
Sacramento River winter-run Chinook salmon	Adult	Natural	137	4	65.238	1.905
		Listed Hatchery Adipose Clip	131	4	5.869	0.179
	Juvenile	Natural	6,957	173	3.561	0.089
		Listed Hatchery Adipose Clip	2,959	869	1.480	0.434
Central Valley spring-run Chinook salmon	Adult	Natural	257	9	6.896	0.241
		Listed Hatchery Adipose Clip	247	9	10.867	0.396
	Juvenile	Natural	10,759	216	1.387	0.028
		Listed Hatchery Adipose Clip	3,554	2,159	0.164	0.100
California Central Valley Steelhead	Adult	Natural	417	14	24.733	0.830
		Listed Hatchery Adipose Clip	1,617	34	41.935	0.882
	Juvenile	Natural	737	29	0.117	0.005
		Listed Hatchery Adipose Clip	2,272	69	0.142	0.004
Central California Coast coho salmon	Adult	Natural	5	0	0.259	0.000
		Listed Hatchery Intact Adipose	10	0	3.058	0.000
	Juvenile	Natural	22,750	455	14.387	0.288
		Listed Hatchery Intact Adipose	25,400	508	15.312	0.306
Central California Coast Steelhead	Adult	Natural	142	0	6.493	0.000
	Juvenile	Natural	39,050	795	15.697	0.320

Table 45. Total requested take for the permits and percentages of the ESA listed species for permits covered in this Biological Opinion

Species	Life Stage	Origin	Requested Take	Lethal Take	Percent of ESU/DPS taken	Percent of ESU/DPS killed
		Listed Hatchery Adipose Clip	100	2	0.015	<0.001
South-Central California Coast Steelhead	Juvenile	Natural	3,200	86	4.048	0.109
Southern California Steelhead	Adult	Natural	10	0	- [a]	- [a]
	Juvenile	Natural	1,290	36		
Southern DPS Eulachon	Adult	Natural	4	1	<0.001	<0.001
Southern DPS green sturgeon	Adult	Natural	38	3	1.804	0.142
	Subadult	Natural	15	1	0.136	0.009
	Juvenile	Natural	76	5	1.732	0.114
	Larvae	Natural	10	10	-	-

[a] Reliable abundance data were not available so percent of ESU/DPS taken or killed was not calculated.

Thus the activities contemplated in this opinion may kill—in combination and at most—as much as two percent of the fish from any component of any listed species; that component is natural-origin adult SacR WR Chinook salmon. It should be noted, however, that this percentage represents the death of only four individuals. In all other instances found in the table above, the effect is (at most) about half of that figure (for adult CCV steelhead) and, in many cases, the effect is several orders of magnitude smaller. And these figures are probably much lower in actuality; for the three permits in which lethal take of adults is requested (13791-7R, 14808-5R, and 19121-2R) these comprehensive programs request a single adult per species and origin in each sampling location, but in total researchers have only used 11.3% of their authorized lethal adult take under these permits over the past five years. But before engaging in that discussion further, it is necessary to add all the take considered in this opinion to the rest of the research take that has been authorized in the West Coast Region.

Table 46. Total expected take of the ESA listed species for scientific research and monitoring already approved for 2020 plus the permits covered in this Biological Opinion

Species	Life Stage	Origin	Requeste d Take	Lethal Take	Percent of ESU/DPS taken	Percent of ESU/DPS killed
	Adult	Natural	959	35	4.463	0.163

Table 46. Total expected take of the ESA listed species for scientific research and monitoring already approved for 2020 plus the permits covered in this Biological Opinion

Species	Life Stage	Origin	Requested Take	Lethal Take	Percent of ESU/DPS taken	Percent of ESU/DPS killed
Puget Sound Chinook salmon		Listed Hatchery Intact Adipose	937	10	11.561[a]	0.388[a]
		Listed Hatchery Adipose Clip	1,151	60		
	Juvenile	Natural	504,179	10,072	15.937	0.318
		Listed Hatchery Intact Adipose	91,613	3,022	1.226	0.040
		Listed Hatchery Adipose Clip	251,955	12,147	0.532	0.026
Puget Sound Steelhead	Adult	Natural	2,003	42	10.583[b]	0.252[b]
		Listed Hatchery Intact Adipose	22	0		
		Listed Hatchery Adipose Clip	34	7		
	Juvenile	Natural	69,283	1,506	3.135	0.068
		Listed Hatchery Intact Adipose	2,391	38	2.125	0.034
		Listed Hatchery Adipose Clip	5,262	108	4.784	0.098
Upper Columbia River Steelhead	Adult	Natural	235	4	12.170	0.207
		Listed Hatchery Intact Adipose	94	2	8.083	0.172
		Listed Hatchery Adipose Clip	219	6	4.125	0.113
	Juvenile	Natural	47,733	973	23.941	0.488
		Listed Hatchery Intact Adipose	4,618	123	3.332	0.089
		Listed Hatchery Adipose Clip	19,634	444	2.856	0.065
Middle Columbia River Steelhead	Adult	Natural	1,432	20	28.345	0.396
		Listed Hatchery Intact Adipose	169	6	150.893	5.357

Table 46. Total expected take of the ESA listed species for scientific research and monitoring already approved for 2020 plus the permits covered in this Biological Opinion

Species	Life Stage	Origin	Requested Take	Lethal Take	Percent of ESU/DPS taken	Percent of ESU/DPS killed
		Listed Hatchery Adipose Clip	933	12	208.259	2.679
	Juvenile	Natural	118,935	2,521	29.172	0.618
		Listed Hatchery Intact Adipose	9,282	135	8.402	0.122
		Listed Hatchery Adipose Clip	900	43	0.202	0.010
Lower Columbia River Chinook salmon	Adult	Natural	325	16	1.103	0.054
		Listed Hatchery Intact Adipose	12	0	0.420[a]	0.034[a]
		Listed Hatchery Adipose Clip	150	13		
	Juvenile	Natural	768,299	10,593	6.541	0.090
		Listed Hatchery Intact Adipose	315	36	0.033	0.004
		Listed Hatchery Adipose Clip	53,917	1,566	0.172	0.005
Lower Columbia River coho salmon	Adult	Natural	1,423	18	4.765	0.060
		Listed Hatchery Intact Adipose	31	0	7.280[a]	0.466[a]
		Listed Hatchery Adipose Clip	609	41		
	Juvenile	Natural	180,218	2,563	27.245	0.387
		Listed Hatchery Intact Adipose	560	112	0.224	0.045
		Listed Hatchery Adipose Clip	53,576	1,857	0.735	0.025
Lower Columbia River Steelhead	Adult	Natural	2,834	32	21.935	0.248
		Listed Hatchery Adipose Clip	86	4	0.386	0.018
	Juvenile	Natural	68,657	1,186	19.497	0.337

Table 46. Total expected take of the ESA listed species for scientific research and monitoring already approved for 2020 plus the permits covered in this Biological Opinion

Species	Life Stage	Origin	Requested Take	Lethal Take	Percent of ESU/DPS taken	Percent of ESU/DPS killed
		Listed Hatchery Intact Adipose	3	0	0.033	0.000
		Listed Hatchery Adipose Clip	41,026	619	3.427	0.052
Columbia River chum salmon	Adult	Natural	40	6	0.376	0.056
		Listed Hatchery Intact Adipose	1	0	0.235	0.000
	Juvenile	Natural	39,188	500	0.591	0.008
		Listed Hatchery Intact Adipose	567	18	0.094	0.003
		Listed Hatchery Adipose Clip	10	0	- [c]	- [c]
Upper Willamette River Chinook salmon	Adult	Natural	207	6	2.029	0.059
		Listed Hatchery Adipose Clip	171	13	0.543	0.041
	Juvenile	Natural	45,952	729	3.792	0.060
		Listed Hatchery Intact Adipose	46	3	1.092	0.071
		Listed Hatchery Adipose Clip	9,870	300	0.210	0.006
Upper Willamette River Steelhead	Adult	Natural	228	4	7.830	0.137
	Juvenile	Natural	12,447	249	8.866	0.177
Southern Oregon/Northern California Coast coho salmon	Adult	Natural	1,636	17	18.047	0.188
		Listed Hatchery Intact Adipose	1,795	4	21.813[a]	0.137[a]
		Listed Hatchery Adipose Clip	590	11		
	Juvenile	Natural	209,889	3,004	10.424	0.149
		Listed Hatchery Intact Adipose	14,071	662	2.447	0.115
		Listed Hatchery Adipose Clip	3,938	64	1.969	0.032

Table 46. Total expected take of the ESA listed species for scientific research and monitoring already approved for 2020 plus the permits covered in this Biological Opinion

Species	Life Stage	Origin	Requested Take	Lethal Take	Percent of ESU/DPS taken	Percent of ESU/DPS killed
Northern California Steelhead	Adult	Natural	925	19	12.810	0.263
	Juvenile	Natural	232,663	3,535	28.326	0.430
California Coastal Chinook salmon	Adult	Natural	475	15	6.753	0.213
	Juvenile	Natural	297,744	3,813	23.296	0.298
Sacramento River winter-run Chinook salmon	Adult	Natural	306	21	145.714	10.000
		Listed Hatchery Adipose Clip	220	56	9.857	2.509
	Juvenile	Natural	177,973	5,210	91.103	2.667
		Listed Hatchery Adipose Clip	13,795	1,795	6.897	0.898
Central Valley spring-run Chinook salmon	Adult	Natural	759	32	20.365	0.859
		Listed Hatchery Adipose Clip	664	60	29.212	2.640
	Juvenile	Natural	876,197	17,097	112.989	2.205
		Listed Hatchery Adipose Clip	18,615	3,371	0.858	0.155
California Central Valley Steelhead	Adult	Natural	4,010	95	237.841	5.635
		Listed Hatchery Adipose Clip	2,263	90	58.688	2.334
	Juvenile	Natural	67,069	2,086	10.639	0.331
		Listed Hatchery Adipose Clip	26,517	1,706	1.657	0.107
Central California Coast coho salmon	Adult	Natural	3,661	53	189.493	2.743
		Listed Hatchery Intact Adipose	1,700	33	519.878	10.092
	Juvenile	Natural	200,107	3,662	126.546	2.316
		Listed Hatchery Intact Adipose	84,740	1,957	51.085	1.180
Central California Coast Steelhead	Adult	Natural	2,732	45	124.920	2.058
		Listed Hatchery Adipose Clip	487	12	12.597	0.310

Table 46. Total expected take of the ESA listed species for scientific research and monitoring already approved for 2020 plus the permits covered in this Biological Opinion

Species	Life Stage	Origin	Requested Take	Lethal Take	Percent of ESU/DPS taken	Percent of ESU/DPS killed
	Juvenile	Natural	248,753	5,570	99.993	2.239
		Listed Hatchery Intact Adipose	6,200	124	-	-
		Listed Hatchery Adipose Clip	12,880	354	1.985	0.055
South-Central California Coast Steelhead	Adult	Natural	1,178	12	169.496	1.727
	Juvenile	Natural	46,698	1,240	59.069	1.568
Southern California Steelhead	Adult	Natural	55	8	- [c]	- [c]
	Juvenile	Natural	22,990	621		
Southern DPS Eulachon	Adult	Natural	33,826	31,055	0.111[d]	0.102[d]
	Subadult	Natural	1,030	1,030		
	Juvenile	Natural	540	456		
Southern DPS green sturgeon	Adult	Natural	515	13	24.454	0.617
	Subadult	Natural	81	6	0.733	0.054
	Juvenile	Natural	1,760	116	40.119	2.644
	Larvae	Natural	11,015	1,015	- [c]	- [c]
	Egg	Natural	1,350	1,350		

[a] Abundances for adult hatchery salmonids are Listed Hatchery Adipose Clip and Listed Hatchery Intact Adipose combined.
[b] Abundances for all adult components are combined.
[c] Reliable abundance data were not available for this calculation.
[d] Abundance for these species are only known for the adult life stage which is used to represent the entire DPS.

As the table above illustrates, in many cases the dead fish from all of the permits in this opinion and all the previously authorized research would amount to a less than half a percent of each species' total abundance. In these instances, the total mortalities are so small and so spread out across each listed unit that they are unlikely to have any lasting detrimental effect on the species' numbers, reproduction, or distribution.

However, in 22 cases involving eight species, the total potential mortality could amount to a more substantial percentage of an ESU component (i.e., life stage and origin). As a result, we will review the potential mortality in these instances in more detail.

Salmonid Species

As Tables 45 and 46 illustrate, in most instances, the research—even in total—would have only very small effects on any species' juvenile abundance (and therefore productivity) and no discernible effect on structure or diversity because the effects would be attenuated across each entire species. Nonetheless, there are some instances where closer scrutiny of the effects on a particular component is warranted. The newly proposed research, when considered with research already authorized would potentially kill more than half of one percent of the estimated abundance of an adult or juvenile component of the following listed species: MCR steelhead, SacR WR Chinook salmon, CVS Chinook salmon, CCV steelhead, CCC coho salmon, CCC steelhead, and SCCC steelhead. Detailed descriptions of these effects for juveniles and adults follow in the paragraphs below.

A few considerations apply generally to our analyses of the total mortalities that would be permitted (i.e. take considered in this opinion added to the rest of the research take that has been authorized in the West Coast Region; Table 46) for juveniles and adults of each of these species. First, we do not expect the potential mortality of adipose-fin-clipped, hatchery-origin fish contemplated in this opinion to have any genuine effect on the species' survival and recovery in the wild because, while they are listed, they are considered surplus to recovery needs. We therefore focus primarily on the naturally produced ESU or DPS components.

Second, the true numbers of fish that would actually be taken would most likely be smaller than the amounts authorized. We develop conservative estimates of abundance, as described in Section 2.2 above. As noted repeatedly in the effects section, the researchers generally request more take than they estimate will actually occur. It is therefore very likely that researchers will take fewer fish than estimated, and that the actual effect is likely to be lower than the numbers stated in the tables above. The degree to which these values are likely overestimates, based on actual reported data from recent years of the research program, is discussed for each species and age class in the following sections.

Another reason effects on natural-origin components of each listed unit may be smaller than the values in the tables above is how we ask researchers to report taken fish of unknown origin. In those instances where a non-clipped hatchery fish cannot be differentiated from a natural-origin fish, we ask that researchers err to the side of caution and treat all fish with intact adipose fins as if they were natural-origin fish. So for instance, given that for the MCR steelhead, unclipped hatchery fish make up approximately 39% of the animals with intact adipose fins, it is undoubtedly the case that some unclipped fish would be taken and counted as natural-origin fish. Therefore, in most cases, the natural-origin component would in actuality be affected to a lesser degree than the percentages displayed above. It is not possible to know *how much* smaller the take figures would be, but that they are smaller is not in doubt. The overall percentages for the listed unit would, however, remain at the same low levels shown.

Lastly, the research being conducted in the region adds critical knowledge about the species' status—knowledge that we are required to have every five years to perform status reviews for all listed species. So in evaluating the impacts of the research program, any effects on abundance and productivity are weighed in light of the potential value of the information collected as a result of the research. Regardless of its relative magnitude, the negative effects associated with the research program on these species would to some extent be offset by gaining information that would be used to help the species survive and recover.

As described in further detail below, because we found for each ESU and DPS that:

1. We expect the research activities' detrimental effects on the species' abundance and productivity to be small, even in combination with all the rest of the research authorized in the basin; and
2. That slight impact would be distributed throughout the species' entire range and would therefore be so attenuated as to have no appreciable effect on spatial structure or diversity.

We determined that the impact of the research program—even in its entirety—is a small effect on abundance and productivity, and that the activities analyzed here would add only a small increment to that impact. Also, those small effects of the research program on abundance and productivity are offset to some degree by the beneficial effects of the program as a whole in fulfilling a critical role in promoting the species' health by generating information managers need to help them recover.

Juveniles

The newly proposed research would, in combination with mortalities already authorized for research in the region, necessitate further discussion of potential effects on juvenile MCR steelhead, SacR WR Chinook salmon, CVS Chinook salmon, CCC coho salmon, CCC steelhead, and SCCC steelhead.

For all of these ESUs and DPSs, the majority of the stated take in Table 46 has already been analyzed in previous opinions and been determined not to jeopardize any of the species considered here. In addition, for these species effects from the activities contemplated in this opinion were found to incur losses that are very small, the effects are only seen in reductions in abundance and productivity and, as described above, the estimates of mortalities are almost certainly much greater than the actual numbers are likely to be. Data from our tracking system demonstrates that for the research program as a whole, over the past five years (2015-2019) researchers only actually killed about 12% of the juvenile fish they were allotted as authorized mortalities (and only 9.7% of natural-origin mortalities). This means that the take levels for juveniles are likely to actually be something on the order of one tenth of the numbers displayed in the tables above. Still, even in the worst case scenario (which assumes that all authorized mortalities would occur), for all ESUs and DPSs the effects would be small and restricted to abundance and productivity reductions, and to some degree the negative effects would be offset by the information to be gained—information that in all cases would be used to protect listed fish or promote their recovery. The specific circumstances of each ESU and DPS warranting further evaluation are discussed in detail below.

Middle Columbia River steelhead

A figure requiring a closer view is the 0.618% of the natural-origin MCR steelhead juveniles killed by research activities in the Deschutes River basin. The actions considered in this opinion would appear to add 18 fish to the total being allotted, but in fact would actually add none because all those fish are part of the Deschutes River NEP and are therefore considered excess to the DPS's recovery needs. Thus, the 0.618% actually represents no increase in the amount of take that has previously been found to not jeopardize the species.

Out of an abundance of caution, we analyze the effect of removing juveniles from the NEP as if they were part of the listed unit, but in fact it will be five years until they are actually considered to be part of the MCR steelhead DPS. Still, if the all the fish that are permitted to be taken were to be taken in fact, it would likely result in small but measurable abundance and productivity losses for the DPS.

However, it should also be noted that for the last five years, the yearly average amount of natural MCR steelhead juvenile taken is only 24.2% of what has been permitted—and the average mortality rate has averaged only 11% of what has been permitted (APPS permit website). As a result, the effects of the program as a whole are very likely to be much smaller than those displayed above—probably around a tenth of the figure displayed. And in either case, the losses would be spread out across the species' entire range, so there would be no measurable effect on structure or diversity, and no single population would bear the brunt of the effect. The impact of the program—even in its entirety—is a very small effect on abundance and productivity, the activities analyzed here would add effectively no increment to that impact, and the information gained from the program as a whole would generate lasting benefits for the listed fish.

Sacramento River Winter Run Chinook salmon

When combined with scientific research and monitoring permits already approved the potential mortality for juvenile SacR WR Chinook salmon would range from 0.9% for hatchery-origin fish to 2.7% for naturally produced fish. Thus the projected total lethal take for all research and monitoring activities represents a notable portion of the species' total abundance, however absolute numbers of natural-origin mortalities authorized are relatively low (5,210 juveniles; Table 46). Further, the activities contemplated in this opinion represent only fractions of those already small numbers. The potential mortality for natural-origin SacR WR Chinook salmon due to activities contemplated in this opinion represents only 1.9% of the abundance of naturally produced juveniles and only 0.18% of the abundance of hatchery-origin juveniles. The total mortalities considered in this opinion are only 173 of the combined total 5,210 mortalities (3.3%) that would be authorized in the region (Tables 45 and 46). Therefore, nearly all of the total potential juvenile mortality for natural-origin SacR WR Chinook salmon has been previously analyzed and found not to jeopardize the species, and the work contemplated here would add very little to that effect.

It is also very likely that researchers will take fewer fish than estimated, and that the actual effects would be lower than the numbers stated in the tables above. Our research tracking system reveals that over the past five years (2015-2019) researchers ended up taking on average 21% of the naturally produced SacR WR Chinook salmon juveniles they were authorized for the year, and the actual lethal take of natural-origin juveniles averaged only 12% of the mortalities authorized. This would mean that the actual effect is likely to be roughly one tenth of what is displayed in the table above. Thus, we expect the research activities' detrimental effects on the species' abundance and productivity to be small—even in combination with all the rest of the research authorized in the basin. And because that slight impact would be distributed throughout the species' entire range, it would be so attenuated as to have no appreciable effect on spatial structure or diversity. So once again, the impact of the program—even in its entirety—is a small effect on abundance and productivity, the activities analyzed here would add only a small increment to that impact, and the information gained from the program as a whole would generate lasting benefits for the listed fish.

Central Valley Spring Run Chinook salmon

When combined with scientific research and monitoring permits already approved, the potential mortality for naturally produced juvenile CVS Chinook salmon would be about 2.2% (Table 46). Thus the projected total lethal take for all research and monitoring activities in the region represents a small percent of the species' total abundance. Further, the activities contemplated in this opinion represent only fractions of that already small number. The potential mortality of CVS Chinook salmon resulting from activities contemplated in this opinion would equate to only 0.03% of the abundance of natural-origin juveniles (Table 45). These 216 juvenile mortalities would account for only 1.2% of the total permitted lethal take for the region (17,097 authorized mortalities; Table 46). Therefore, nearly all of the total potential juvenile mortality for natural-origin CVS Chinook salmon has been previously analyzed and found not to jeopardize the species, and the work contemplated here would add very little to that low effect.

It is also very likely that researchers will take fewer fish than estimated, and that the actual effects would be lower than the numbers stated in the tables 45 and 46 above. For naturally produced CVS Chinook, our research tracking system reveals that for the past five years, researchers ended up taking on average only 5.7% of the juveniles they requested, and the actual mortality rates also averaged only 5.9% of what was requested for juveniles. This would mean that the actual effect is likely to be on the order of one-twentieth of the impact displayed in the table above. Thus, we expect the research activities' detrimental effects on the species' abundance and productivity to be small—even in combination with all the rest of the research authorized in the basin. And because that slight impact would be distributed throughout the species' entire range, it would be so attenuated as to have no appreciable effect on spatial structure or diversity. We therefore find that the impact of the program—even in its entirety—is a small effect on abundance and productivity, the activities analyzed here would add only a small increment to that impact, and the information gained from the program as a whole would generate lasting benefits for the listed fish.

Central California Coast coho salmon

When combined with scientific research and monitoring permits already approved, the potential mortality for juvenile CCC coho salmon would be 2.3% for natural-origin fish and 1.2% for hatchery-origin fish (Table 46). The activities contemplated in this opinion represent only portions of those small numbers. The potential mortality for natural-origin CCC coho salmon resulting from activities contemplated in this opinion would account for only 12% of the permitted lethal take for the region (455 of the 3,662 authorized mortalities), and represents only 0.29% of the abundance of natural-origin juveniles. For the hatchery component of this ESU, about 26% percent of the juvenile mortality (508 of 1,957 authorized mortalities) would result from activities contemplated in this opinion, representing only 0.31% of the hatchery-origin juvenile abundance. Therefore, the majority of the total potential mortality for both the hatchery and natural-origin components has been previously analyzed and found not to jeopardize the species.

It is also very likely that researchers will take fewer fish than estimated, and that the actual effect is likely to be lower than the numbers stated in the table above. Our research tracking system reveals that for the past five years, researchers ended up taking 13% of the juveniles they requested and the actual mortality was only 3.6% of the juveniles authorized to be killed. We would therefore expect that the actual mortality numbers are very likely to be less than one-twentieth of the numbers stated in the table above. Thus, we expect the research activities' detrimental effects on the species' abundance and productivity to be small—even in combination with all the rest of the research authorized in the basin. And because that slight impact would be distributed throughout the species' entire range, it would be so attenuated as to have no appreciable effect on spatial structure or diversity. We therefore find the impact of the program—even in its entirety—is a small effect on abundance and productivity, the activities analyzed here would add only a small increment to that impact, and the information gained from the program as a whole would generate lasting benefits for the listed fish.

Central California Coast steelhead

When combined with scientific research and monitoring permits already approved, the potential mortality for natural juvenile CCC steelhead would be 2.2% of estimated species abundance (Table 46). The activities contemplated in this opinion represent only a portion of that small number. The potential mortality for natural-origin CCC steelhead resulting from activities contemplated here would account for 14% of the permitted lethal take for the region (795 of the 5,570 authorized mortalities), representing only 0.32% of the naturally produced juvenile abundance. Therefore, the great majority of the displayed potential mortality has been previously analyzed and found not to jeopardize the species.

In addition, the true numbers of fish that would actually be taken would most likely be smaller than the amounts authorized. Our research tracking system reveals that for the past five years, researchers ended up taking 13% of the juvenile CCC steelhead they requested and the actual mortality was only 4.0% of the juveniles authorized to be killed. This would mean that the actual effect of mortalities is likely to be on the order of one-twentieth of the effect displayed in the table above. Thus, we expect the research activities' detrimental effects on the species' abundance and productivity to be small—

even in combination with all the rest of the research authorized in the basin. And because that slight impact would be distributed throughout the species' entire range, it would be so attenuated as to have no appreciable effect on spatial structure or diversity. We therefore find the impact of the program—even in its entirety—is a small effect on abundance and productivity, the activities analyzed here would add only a small increment to that impact, and the information gained from the program as a whole would generate lasting benefits for the listed fish.

South-Central California Coast steelhead

When combined with scientific research and monitoring permits already approved, the potential mortality for juvenile natural-origin SCCC steelhead would be 1.6% (Table 46). Thus the projected total lethal take for all research and monitoring activities represents a small percent of the species' total abundance, and the activities contemplated in this opinion would account for only a small fraction of that already small effect—6.9% (86 of the 1,240) of total authorized mortalities, representing 0.11% of the juvenile abundance of this DPS. Therefore, nearly all of the displayed potential mortality has been previously analyzed and found not to jeopardize the species.

In addition, it is likely that researchers will take fewer fish than estimated, and that the actual effect is likely to be lower than the numbers stated in the table above. Our research tracking system reveals that for the past five years, researchers ended up taking 17% of the juvenile naturally-produced SCCC steelhead they were authorized, and the actual mortality rate was only 3.2% of the mortalities authorized for juveniles. This would mean that the actual effect of mortalities is likely to be less than a twentieth of the effect displayed in the table above. Thus, we expect the research activities' detrimental effects on the species' abundance and productivity to be small—even in combination with all the rest of the research authorized in the basin. And because that slight impact would be distributed throughout the species' entire range, it would be so attenuated as to have no appreciable effect on spatial structure or diversity. We therefore find the impact of the program—even in its entirety—is a small effect on abundance and productivity, the activities analyzed here would add only a small increment to that impact, and the information gained from the program as a whole would generate lasting benefits for the listed fish.

Adults

For the adults, the research effects are similar to those described for the juveniles. However, killing an adult fish has a potentially much greater effect than killing a juvenile, so it is necessary to examine more closely some of those impacts. The newly proposed research would, in combination with mortalities already authorized for research in the region, necessitate further discussion of potential effects on adult MCR steelhead, SacR WR Chinook salmon, CVS Chinook salmon, CCV steelhead, CCC coho salmon, CCC steelhead, and SCCC steelhead.

As with the juveniles, so few adults from any species would be killed by the new proposed research that nearly all of the stated take in Table 46 has already been analyzed in previous opinions and been determined not to jeopardize any of the species considered here. For the California coastal species

(CCC coho salmon, CCC and SCCC steelhead) no new adult mortalities would be authorized under the activities considered in this opinion, so all of the take in Table 46 has been previously determined not to jeopardize these species.

For species where new adult mortalities would be authorized, effects from the activities contemplated in this opinion were found to incur losses that are very small, the effects are only seen in reductions in abundance and productivity and, as described above, the estimates of mortalities are almost certainly much greater than the actual numbers are likely to be. Data from our tracking system demonstrates that for the research program as a whole, over the past five years (2015-2019) researchers only actually killed about 3.9% of the all the adult fish they were allotted as authorized mortalities (and only 3.2% of the permitted natural-origin mortalities). This means that the take levels for adults listed in Table 46 are likely to actually be something on the order of less than one twentieth of the numbers displayed in the tables above. Still, even in the worst case scenario assuming all authorized mortalities did occur, for all ESUs and DPSs the effects would be small and restricted to abundance and productivity reductions, and to some degree the negative effects would be offset by the information to be gained—information that in all cases would be used to protect listed fish or promote their recovery. The specific circumstances of each ESU and DPS warranting further evaluation are discussed in detail below.

Middle Columbia River Steelhead

The two figures that stand out and require closer scrutiny are the 5.36% of intact adipose fish and 2.68% of the adipose-clipped fish that all the research in the region may kill, in total. While it should be noted that these figures actually represent no increase in the baseline take, it still means that as many as 2.7% adipose-clipped adult hatchery fish, and 5.4 intact-adipose fish out of every hundred would be killed every year by the research efforts in the basin. However, and for a number of reasons, these minor effects have repeatedly been determined to not jeopardize the species and, in any case, the information being generated is used in critical status monitoring and recovery efforts.

There are two main mitigating circumstances that have led to previous “no jeopardy” conclusions with regard to these levels of take. First, in the case if the intact-adipose-fin fish, the great majority of the fish being taken come from a single permit: 17306, held by the ODFW and used to monitor fish health across the Deschutes River basin. This one permit accounts for 130 out of the total 169 adult intact-adipose fish that may be killed in the research program. Moreover, all of those 130 fish are actually part of the Deschutes River NEP (see the Permit 23649 write-up above for more information)—an experimental population that is considered in its entirety to be surplus to the recovery needs of the MCR steelhead. This means that the research program as a whole may actually kill only about 1.26% of the adult, intact-adipose-fin hatchery fish. Similarly, a large number of the adipose-clipped fish that may be killed under the research program come from the NEP under Permit 17306—130 out of 933. This means that the research program may kill around 2.3% of the adult adipose-clipped MCR steelhead. Further, given that in the last five years, the ODFW has killed no adult fish of any kind under Permit 17306, these lower figures (1.26% and 2.3%) are even more likely to be representative of the program’s gross effect.

Nonetheless, if all the take represented in these two (lowered) figures were actually to occur, it would likely result in small but measurable abundance and productivity losses. These losses would be spread out across the species' entire range (so no measurable effect to structure or diversity), and they would be more acute for the intact-adipose-fin hatchery fish than for the adipose-clipped fish (even though the latter percentage is higher).

The second of the two mitigating circumstances is that, as previously noted, adipose-clipped hatchery fish are considered surplus to all species' recovery needs and, for example, are allowed to be retained in fisheries throughout the basin. They are listed under the ESA, so we must analyze any impacts on them, but the status of this adipose-fin-clipped component is such that losses of that type—some even greater than the approximately 2.3% contemplated here—have been repeatedly determined not to jeopardize *any* listed salmonids, including MCR steelhead.

Lastly, it is important to keep in mind the fact that losses of the magnitudes described are extremely unlikely to occur at all. This is illustrated by the fact that over the last five years (2015-2019), the region's researchers have taken a yearly average of about 16.5% of natural-origin adult MCR steelhead they were permitted and killed only about 6.4% of those they were permitted to lethally take (APPS permit website). This would signify that the actual mortality rates are probably a great deal less than a tenth of what is displayed.

But here again, even if the rates were as high as those in Table 46, the research being conducted in the region adds critical knowledge about the species' status. We therefore find the impact of the program—even in its entirety—is a small effect on abundance and productivity, the activities analyzed here would add only a small increment to that impact, and the information gained from the program as a whole would generate lasting benefits for the listed fish.

Sacramento River Winter Run Chinook salmon

When combined with scientific research and monitoring permits already approved the potential mortality for adult SacR WR Chinook salmon could equal as much as 10% of estimated species abundance (Table 46). Thus the projected total lethal take for all research and monitoring activities represents a notable portion of the species' total abundance, however absolute numbers of natural-origin mortalities authorized are low, totaling 21 adults. Further, the activities contemplated in this opinion represent only fractions of those already small numbers. The potential mortality for natural-origin SacR WR Chinook salmon due to activities contemplated in this opinion would account for only 1.9% of the estimated adult salmon abundance, almost a quarter (4 of 21) of the authorized mortalities in the region (Table 45). Therefore, the majority of the potential adult mortality for natural-origin SacR WR Chinook salmon has been previously analyzed and found not to jeopardize the species. We do not expect the potential mortality of adult hatchery-origin fish contemplated in this opinion to have any genuine effect on the species' survival and recovery in the wild as these fish are considered surplus to recovery needs.

In addition, it is likely that researchers will take fewer fish than estimated, and that the actual effect is likely to be lower than the numbers stated in the table above. Our research tracking system reveals that over the past five years researchers ended up taking 9.0% of the naturally produced adults they requested, and the actual mortality of natural-origin adults was only 3.7% of the mortalities authorized. This would mean that the actual effect is very likely to be less than one-twentieth of the magnitude displayed in the tables above. Thus, we expect the research activities' detrimental effects on the species' abundance and productivity to be small—even in combination with all the rest of the research authorized in the basin. And because that slight impact would be distributed throughout the species' entire range, it would be so attenuated as to have no appreciable effect on spatial structure or diversity. We therefore find the impact of the program—even in its entirety—is a small effect on abundance and productivity, the activities analyzed here would add only a small increment to that impact, and the information gained from the program as a whole would generate lasting benefits for the listed fish.

Central Valley Spring Run Chinook salmon

When combined with scientific research and monitoring permits already approved, the potential mortality rates for adult CVS Chinook salmon would be about 0.9% for the natural component and about 2.6% of the hatchery-origin component (Table 46). The hatchery adults are considered surplus to recovery needs, therefore, we do not expect the 2.6% loss to have any genuine effect on the species' survival and recovery in the wild. The projected total lethal take for all research and monitoring activities represent a small percent of the species' natural-origin adult abundance. The activities contemplated in this opinion would constitute about 28% of that small effect (9 of the 32 authorized mortalities), which represents 0.24% of the natural origin adult abundance of this ESU. Therefore, the majority of the potential adult mortality has been previously analyzed and found not to jeopardize the species.

In addition, it is very likely that researchers will take fewer fish than estimated, and that the actual effect is likely to be lower than the numbers stated in Tables 45 and 46 above. For naturally produced CVS Chinook, our research tracking system reveals that over the past five years researchers ended up taking 4.5% of the adults they were permitted, and the actual mortality was less than 1% of the mortalities authorized for adults. This would mean that the actual effect is likely to be about on one-hundredth of the effect displayed in the table above, or near zero for adults. Thus, we expect the research activities' detrimental effects on the species' abundance and productivity to be small—even in combination with all the rest of the research authorized in the basin. And because that slight impact would be distributed throughout the species' entire range, it would be so attenuated as to have no appreciable effect on spatial structure or diversity. We therefore find the impact of the program—even in its entirety—is a small effect on abundance and productivity, the activities analyzed here would add only a small increment to that impact, and the information gained from the program as a whole would generate lasting benefits for the listed fish.

California Central Valley steelhead

When combined with scientific research and monitoring permits already approved, the potential mortality for adult CCV steelhead would range from 2.3% to 5.6% of estimated species abundance—depending on origin (Table 46). The 5.6% potential mortality figure is for natural-origin adult fish. The hatchery-origin fish are considered surplus to recovery needs, therefore, we do not expect the loss of 2.3% of this DPS component to have any genuine effect on the species' survival and recovery in the wild. Thus the projected total lethal take for all research and monitoring activities represents a small percent of the species' total abundance. The activities contemplated in this opinion constitute about 15% of the authorized take in the region (14 of 95 mortalities), which represents 0.83% of the estimated abundance of natural-origin adults (Tables 45 and 46). Therefore, the great majority of the displayed potential mortality of concern has been previously analyzed and found not to jeopardize the species.

In addition, it is very likely that researchers will take fewer fish than estimated, and that the actual effect is likely to be lower than the numbers stated in the tables above. For naturally produced CCV steelhead, our research tracking system reveals that for the past five years (2015-2019) researchers only ended up taking 4.5% of the adults they were authorized, and the actual mortality was only 0.98% of the total mortalities authorized for adults. This would mean that the actual effect of mortalities is likely to be on the order of on one-hundredth of the effect displayed in the table above.

Thus, the losses are very small, the effects are only seen in reductions in abundance and productivity, and the estimates of adult mortalities are almost certainly much greater than the actual numbers are likely to be. And because that slight impact would be distributed throughout the entire listing units' ranges, it would be so attenuated as to have no appreciable effect on spatial structure or diversity. Still, even in the worst case scenarios the effects are tiny, restricted to abundance and productivity reductions, and to some degree the negative effects would be offset by the information to be gained—information that in all cases would be used to protect listed fish or promote their recovery.

Central California Coast coho salmon

When combined with scientific research and monitoring permits already approved, the potential mortality for CCC coho salmon would range from 2.7% to 10% of estimated species abundance—depending on origin (Table 46). The 10% potential mortality figure is for adult hatchery-origin fish (which, again, are considered surplus to recovery needs and are allowed to be retained in fisheries). The total potential mortality for adult natural-origin CCC coho salmon is 2.7% of estimated species abundance. However, the activities contemplated in this opinion would not authorize any additional mortality of adults (i.e., would only authorize non-lethal take and no unintentional mortalities) for natural- or hatchery-origin fish. Therefore, all of the total potential mortality for hatchery and natural-origin components has been previously analyzed and found not to jeopardize the species.

It is also very likely that researchers will take fewer fish than estimated for take that is already authorized, and that the actual effect is likely to be lower than the numbers stated in Table 46. Our research tracking system reveals that for the past five years (2015-2019) researchers ended up taking only 5.0% of natural-origin adults authorized, and the actual total number of adults killed across the research program (10 individuals over five years) was only 4.1% of the authorized natural-origin adult mortalities. We would therefore expect that the actual effects of previously authorized activities would like be on the order of one-twentieth of the effect displayed in Table 46 above, and no additional mortalities of adults would occur compared to the baseline. We therefore find the impact of the program—even in its entirety—is a small effect on abundance and productivity, the activities analyzed here would not add to that impact, and the information gained from the program as a whole would generate lasting benefits for the listed fish.

Central California Coast steelhead

When combined with scientific research and monitoring permits already approved, the potential mortality for natural CCC steelhead would be 2.1% of estimated natural-origin adult abundance (Table 46). The activities contemplated in this opinion represent no increase in that figure because this opinion would authorize no new adult mortalities (natural- or hatchery-origin). Therefore, the all of the displayed potential mortality has been previously analyzed and found not to jeopardize the species.

It is also very likely that researchers will take fewer fish than estimated for take that is already authorized, and that the actual effect is likely to be lower than the numbers stated in Table 46. Our research tracking system reveals that for the past five years (2015-2019) researchers ended up taking only 3.5% of natural-origin adults authorized, and the actual total number of adults killed across the research program (four individuals over five years) was only 1.5% of the authorized natural-origin adult mortalities. We would therefore expect that the actual effects of previously authorized activities would like be on the order of one-hundredth of the effect displayed in Table 46 above, and no additional mortalities of adults would occur compared to the baseline. We therefore find the impact of the program—even in its entirety—is a small effect on abundance and productivity, the activities analyzed here would not add to that impact, and the information gained from the program as a whole would generate lasting benefits for the listed fish.

South-Central California Coast steelhead

When combined with scientific research and monitoring permits already approved, the potential mortality for natural adult SCCC steelhead would be 1.7% (Table 46). The activities contemplated in this opinion represent no increase in that figure because this opinion would authorize no new adult mortalities. Therefore, all of the displayed potential mortality has been previously analyzed and found not to jeopardize the species.

In addition, the true numbers of fish that would actually be taken would most likely be smaller than the amounts authorized. Our research tracking system reveals that for the past five years (2015-

2019) researchers have not taken or killed a single adult SCCC steelhead. It is therefore likely that the program as a whole would have essentially no impact in any given year. Thus, we expect the research activities' detrimental effects on the species' abundance and productivity to be small—even in combination with all the rest of the research authorized in the basin. And because that slight impact would be distributed throughout the species' entire range, it would be so attenuated as to have no appreciable effect on spatial structure or diversity. We therefore find the impact of the program—even in its entirety—is a small effect on abundance and productivity, the activities analyzed here would add only a small increment to that impact, and the information gained from the program as a whole would generate lasting benefits for the listed fish.

Other species

Beyond the salmonid ESUs and DPSs discussed above, are two additional DPSs of two species. All of these species only have a natural-origin component to their DPS. Of these two, one DPS merits additional discussion.

sDPS green sturgeon: For the juvenile life-stage for sDPS green sturgeon, there is a 0.62% lethal take level authorized for adults and a 2.64% lethal take level authorized for juveniles. However, as with the salmonid species, the majority of take has already been analyzed in previous opinions and been determined not to jeopardize this DPS. The potential mortality of sDPS green sturgeon resulting from activities contemplated in this opinion would equate to only 0.11% of the juvenile abundance and 0.14% of the adult abundance (Table 45). These 3 adult and 5 juvenile mortalities would account for only 23% of the total permitted adult lethal take and 4.3% of the total permitted juvenile take for the region (13 and 116 authorized adult and juvenile mortalities, respectively; Table 46).

It is also very likely that researchers will take fewer fish than estimated, and that the actual effects would be lower than the numbers stated in the tables 45 and 46 above. For sDPS green sturgeon, our research tracking system reveals that for the past five years, researchers ended up lethally taking only 4.3% of the juvenile mortalities they were authorized (24/557 individuals), and have not killed one single adult (0/33). This would mean that the actual effect on juveniles is likely to be on the order of one-twentieth of the impact displayed in the tables above, and essentially zero for adult sturgeon. Thus, we expect the research activities' detrimental effects on the species' abundance and productivity to be small—even in combination with all the rest of the research authorized in the basin. But even if in the worst case scenario all the fish authorized as mortalities were to be killed in actuality, this would represent only a small reduction in overall abundance and productivity, and because that slight impact would be distributed throughout the species' range, it would be so attenuated as to have no appreciable effect on spatial structure or diversity. And finally, regardless of its relative magnitude, all the negative effect associated with the research program on this species would to some extent be offset by gaining information that would be used to help the species survive and recover.

Critical Habitat

As previously discussed, we do not expect the individual actions to have any appreciable effect on any listed species' critical habitat. This is also true for all the proposed permit actions in combination. The actions' short durations, minimal intrusion, and overall lack of measurable effect signify that even when taken together they would have no discernible impact on critical habitat.

Summary

As noted earlier, none of the listed species discussed in this opinion currently has all its biological requirements being met. Their status is such that there must be a substantial improvement in the baseline environmental conditions of their habitat and other factors affecting their survival if they are to begin to approach recovery. In addition, while the future impacts of cumulative effects are uncertain at this time, they are likely to continue to be negative. Nonetheless, in no case would the proposed actions exacerbate any of the baseline limiting factors or negative cumulative effects discussed previously (habitat alterations, etc.), and in all cases, the proposed research may eventually help to limit those adverse effects by increasing our knowledge about the species' requirements, habitat use, and abundance. The effects of climate change are also likely to continue to be negative. However, given the proposed actions' short time frames and limited areas, those negative effects, while somewhat unpredictable, are too small to be effectively gauged as an additional increment of harm over the time span considered in this analysis. Moreover, the actions would in no way contribute to climate change (even locally) and, in any case, many of the proposed actions would actually help monitor the effects of climate change by noting stream temperatures, flows, etc. While we can expect both cumulative effects and climate change to continue their negative trends, it is unlikely that the proposed actions would have any additive impact to the pathways by which those effects are realized (e.g., a slight reduction in salmonid abundance would have no effect on increasing stream temperatures or continuing land development).

To this picture, it is necessary to add the increment of effect represented by the proposed actions. Our analysis shows that the proposed research activities would have slight negative effects on each species' abundance and productivity, but those reductions are so small as to have no more than a very minor effect on the species' survival and recovery. In all cases, even the worst possible effect on abundance is expected to be minor compared to overall population abundance, the activity has never been identified as a threat, and the research is designed to benefit the species' survival in the long term.

For over two decades, research and monitoring activities conducted on anadromous salmonids in the West Coast Region have provided resource managers with a wealth of important and useful information regarding anadromous fish populations. For example, juvenile fish trapping efforts have enabled managers to produce population inventories; PIT-tagging efforts have increased our knowledge of anadromous fish abundance, migration timing, and survival; and fish passage studies have enhanced our understanding of how fish behave and survive when moving past dams and through reservoirs. By issuing research authorizations—including many of those being contemplated again in this opinion—NMFS has allowed information to be acquired that has enhanced resource managers' abilities to make more effective and responsible decisions with respect to sustaining anadromous salmonid populations, mitigating adverse impacts on endangered and threatened salmon and steelhead, and implementing recovery efforts. The resulting information continues to improve our knowledge of the respective species' life histories, specific biological requirements, genetic make-up, migration timing, responses to human activities (positive and negative), and survival in the rivers and ocean. And that information, as a whole, is critical to the species' survival.

Additionally, the information being generated is, to some extent, legally mandated. Though no law calls for the work being done in any particular permit or authorization, the ESA (section 4(c)(2)) requires that we examine the status of each listed species every five years and report on our findings. At that point, we must determine whether each listed species should (a) be removed from the list (b) have its status changed from threatened to endangered, or (c) have its status changed from endangered to threatened. As a result, it is legally incumbent upon us to monitor the status of every species considered here, and the research program, as a whole, is one of the primary means we have of doing that.

Thus, we expect the detrimental effects on the species to be minimal and those impacts would only be seen in terms of slight reductions in juvenile and adult abundance and productivity. And because these reductions are so slight and so distributed across all populations, the actions—even in combination—would have no appreciable effect on the species' diversity or structure. Moreover, we expect the actions to provide lasting benefits for the listed fish and that all habitat effects would be negligible. And finally, we expect the program as a whole and the permit actions considered here to generate information we need to fulfill our mandate under the ESA.

2.8 Conclusion

After reviewing and analyzing the current status of the listed species and critical habitat, the environmental baseline within the action area, the effects of the proposed action, any effects of interrelated and interdependent activities, and cumulative effects, it is NMFS' biological opinion that the proposed actions are not likely to jeopardize the continued existences of PS, LCR, UWR, CC, SacR WR, or CVS Chinook salmon; CR chum salmon; CCC, LCR, or SONCC coho salmon; PS, UCR, MCR, LCR, UWR, NC, CCC, CCV, SCCC, or SC steelhead; sDPS eulachon; or sDPS green sturgeon; or destroy or adversely modify their designated critical habitats.

2.9 Incidental Take Statement

Section 9 of the ESA and Federal regulations pursuant to section 4(d) of the ESA prohibit the take of endangered and threatened species, respectively, without a special exemption. "Take" is defined as to harass, harm, pursue, hunt, shoot, wound, kill, trap, capture or collect, or to attempt to engage in any such conduct. "Harm" is further defined by regulation to include significant habitat modification or degradation that actually kills or injures fish or wildlife by significantly impairing essential behavioral patterns, including breeding, spawning, rearing, migrating, feeding, or sheltering (50 CFR

222.102). "Incidental take" is defined by regulation as takings that result from, but are not the purpose of, carrying out an otherwise lawful activity conducted by the Federal agency or applicant (50 CFR 402.02). Section 7(b)(4) and section 7(o)(2) provide that taking that is incidental to an otherwise lawful agency action is not considered to be prohibited taking under the ESA if that action is performed in compliance with the terms and conditions of this ITS.

In this instance, and for the actions considered in this opinion, there is no incidental take at all. The reason for this is that all the take contemplated in this document would be carried out under permits that allow the permit holders to directly take the animals in question. The actions are considered to be direct take rather than incidental take because in every case their actual purpose is to take the animals while carrying out a lawfully permitted activity. Thus, the take cannot be considered "incidental" under the definition given above. Nonetheless, one of the purposes of an incidental take statement is to lay out the amount or extent of take beyond which individuals carrying out an action cannot go without being in possible violation of section 9 of the ESA. That purpose is fulfilled here by the amounts of direct take laid out in the effects section above (2.5). Those amounts—displayed in the various permits' effects analyses—constitute hard limits on both the amount and extent of take the permit holders would be allowed in a given year. This concept is also reflected in the reinitiation clause just below.

2.10 Reinitiation of Consultation

This concludes formal consultation for "Consultation on the Issuance of 17 ESA Section 10(a)(1)(A) Scientific Research Permits affecting Salmon, Steelhead, Eulachon, and Green Sturgeon in the West Coast Region."

As 50 CFR 402.16 states, reinitiation of consultation is required and shall be requested by the Federal agency or by the Service where discretionary Federal agency involvement or control over the action has been retained or is authorized by law and if: (1) The amount or extent of incidental taking specified in the ITS is exceeded, (2) new information reveals effects of the agency action that may affect listed species or critical habitat in a manner or to an extent not considered in this opinion, (3) the identified action is subsequently modified in a manner that causes an effect to the listed species or critical habitat that was not considered in the biological opinion, or (4) a new species is listed or critical habitat designated that may be affected by the action.

In the context of this opinion, there is no incidental take anticipated and the reinitiation trigger set out in (1) is not applicable. If any of the direct take amounts specified in this opinion's effects analysis section (2.5) are exceeded, reinitiation of formal consultation will be required because the regulatory reinitiation triggers set out in (2) and/or (3) will have been met.

2.11 "Not Likely to Adversely Affect" Determination

NMFS's determination that an action "is not likely to adversely affect" listed species or critical habitat is based on our finding that the effects are expected to be discountable, insignificant, or completely beneficial (USFWS and NMFS 1998). Insignificant effects relate to the size of the impact and should never reach the scale where take occurs; discountable effects are those that are extremely unlikely to occur; and beneficial effects are contemporaneous positive effects without any adverse effects on the species or their critical habitat.

Southern Resident Killer Whales Determination

The Southern Resident Killer Whale (SRKW or "Southern Residents") DPS was listed as endangered on February 16, 2006 (70 FR 69903) and a recovery plan was completed in 2008 (NMFS 2008). A 5-year review under the ESA completed in 2016 concluded that Southern Residents should remain listed as endangered and includes recent information on the population, threats, and new research results and publications (NMFS 2016b). Because NMFS determined the action is not likely to adversely affect SKRWs, this document does not provide detailed discussion of environmental baseline or cumulative effects for the SRKW portion of the action area.

Several factors identified in the final recovery plan for SRKWs may be limiting recovery including quantity and quality of prey, toxic chemicals that accumulate in top predators, and disturbance from sound and vessels. It is likely that multiple threats are acting together to impact the whales. Although it is not clear which threat or threats are most significant to the survival and recovery of Southern Residents, all of the threats identified are potential limiting factors in their population dynamics (NMFS 2008).

SRKWs consist of three pods (J, K, and L) and inhabit coastal waters off Washington, Oregon, and Vancouver Island and are known to travel as far south as central California and as far north as Southeast Alaska (NMFS 2008; Hanson et al. 2013; Carretta et al. 2017). During the spring, summer, and fall months, the whales spend a substantial amount of time in the inland waterways of the Strait of Georgia, Strait of Juan de Fuca, and Puget Sound (Bigg 1982; Ford 2000; Krahn et al. 2002; Hauser et al. 2007; Hanson and Emmons 2010). By late fall, all three pods are seen less frequently in inland waters. In recent years, several sightings and acoustic detections of Southern Residents have been obtained off the Washington and Oregon coasts in the winter and spring (Hanson et al. 2010; Hanson et al. 2013, NWFSC unpubl. data). Satellite-linked tag deployments have also provided more data on the SRKW movements in the winter indicating that K and L pods use the coastal waters along Washington, Oregon, and California during non-summer months.

SRKWs consume a variety of fish species (22 species) and one species of squid (Ford et al. 1998; Ford 2000; Ford and Ellis 2006; Hanson et al. 2010; Ford et al. 2016), but salmon are identified as their primary prey. Southern Residents are the subject of ongoing research, including direct observation, scale and tissue sampling of prey remains, and fecal sampling. Scale and tissue sampling from May to September indicate that their diet consists of a high percentage of Chinook salmon (monthly proportions as high as >90%) (Hanson et al. 2010; Ford et al. 2016). Recently, Ford et al. (2016) confirmed the importance of Chinook salmon to the Southern Residents in the summer months using DNA sequencing from whale feces. Salmon and steelhead made up to 98% of the inferred diet, of which almost 80% were Chinook salmon. Coho salmon and steelhead are also found in the diet in spring and fall months when Chinook salmon are less abundant (Ford et al. 1998; Ford and Ellis 2006; Hanson et al. 2010; Ford et al. 2016). Prey remains and fecal samples collected in inland waters during October through December indicate Chinook salmon and chum salmon are primarily contributors of the whale's diet (NWFSC unpubl. data).

Observations of whales overlapping with salmon runs (Wiles 2004; Zamon et al. 2007; Krahn et al. 2007) and collection of prey and fecal samples have also occurred in the winter months. Preliminary analysis of prey remains and fecal samples sampled during the winter and spring in coastal waters indicated the majority of prey samples were Chinook salmon (80% of prey remains and 67% of fecal samples were Chinook salmon), with a smaller number of steelhead, chum salmon, and halibut (NWFSC unpubl. data). The occurrence of K and L pods off the Columbia River in March suggests the importance of Columbia River spring runs of Chinook salmon in their diet (Hanson et al. 2013). Chinook salmon genetic stock identification from samples collected in winter and spring in coastal waters included 12 U.S. west coast stocks, and over half the Chinook salmon consumed originated in the Columbia River (NWFSC unpubl. data).

At the time of the last status review in 2016 there were 83 SRKWs left in the population (NMFS 2016f). Recent estimates based on a July 2019 survey indicate Southern Residents now total approximately 73 individuals (22 in J pod, 17 in K pod, and 34 in L pod, CWR 2019). The NWFSC continues to evaluate changes in fecundity and mortality rates, and has updated the work on population viability analyses for SRKWs and a science panel review of the effects of salmon fisheries (Krahn et al. 2004; Hilborn et al. 2012; Ward et al. 2013). Following from that work, the data now suggest a downward trend in population growth projected over the next 50 years. As the model projects out over a longer time frame (50 years) there is increased uncertainty around the estimates, however, if all of the parameters in the model remain the same the overall trend shows a decline in later years. To explore potential demographic projections, Lacy et al. (2017) constructed a population viability assessment that considered sublethal effects and the cumulative impacts of threats (contaminants, acoustic disturbance, and prey abundance). They found that over the range of scenarios tested, the effects of prey abundance on fecundity and survival had the largest impact on the population growth rate (Lacy et al. 2017).

The proposed actions may affect Southern Residents indirectly by reducing availability of their preferred prey, Chinook salmon. This analysis focuses on effects on Chinook salmon availability in the ocean because the best available information indicates that salmon are the preferred prey of SRKWs year-round, including in coastal waters, and that Chinook salmon are the preferred salmon prey species. To assess the indirect effects of the proposed action on the SRKW DPS, we considered the geographic area of overlap in the marine distribution of Chinook salmon affected by the action, and the range of SRKWs. We also considered the importance of the affected Chinook salmon ESUs compared to other Chinook salmon runs in Southern Resident diet composition, and the influence of hatchery mitigation programs. As described in the effects analysis for salmonids, approximately 3,551 juvenile and 26 adult Chinook salmon may be killed during the course of the research. As the previous effects analysis illustrated, these losses—even in total—are expected to have only very small effects on salmonid abundance and productivity and no appreciable effect on diversity or distribution for Chinook salmon ESUs. The affected Chinook salmon species are:

- Puget Sound (PS)
- Lower Columbia River (LCR)
- Upper Willamette River (UWR)
- California Coastal (CC)
- Sacramento River winter-run (SacR WR)
- Central Valley spring-run (CVS)

The fact that the research would potentially kill PS, LCR, UWR, CC, SacR WR, and CVS Chinook salmon could affect prey availability to the whales in future years throughout their range.

For the adult take, all of the fish that may be killed from these ESUs (SacR WR and CVS) would only be taken by research after they return to shallower bays and estuaries, and are unlikely to be available as prey to the whales as they feed in offshore areas of the California coast. This impact would therefore likely have a minimal, if any, effect on prey availability for SRKWs.

For the juveniles, the most recent ten-year average smolt-to-adult ratio (SAR) from PIT-tagged Chinook salmon returns is from the Snake River, and indicates that SARs are less than 1% (BPA 2018). If one percent of the 2,375 juvenile CVS Chinook salmon that may be killed by the proposed research activities were otherwise to survive to adulthood, this would translate to the effective loss of up to 24 adult CVS Chinook salmon. For SacR WR, one percent of the 1,042 juvenile Chinook salmon that may be killed would translate to an effective loss of 10-11 adult Chinook salmon. For juvenile PS, LCR, UWR, and CC Chinook salmon one percent of juveniles translates to an effective loss of one or fewer adult Chinook salmon each.

Further, not all Chinook salmon runs are considered priority prey species for SRKW based on diet composition analyses of the whales as well as the spatial or temporal overlap of adult salmon with SRKW habitat use (NMFS and WDFW 2018). Only 2,446 juveniles from priority prey Chinook salmon stocks (PS, LCR, and CVS) would potentially be taken by researchers as a result of the activities considered in this opinion. As described above this would be equivalent to the effective loss of up to one adult PS and LCR Chinook salmon, which are the highest priority prey stocks for SRKWs, and up to 24 adult CVS Chinook salmon. The potential decrease of CVS Chinook salmon is less likely to impact SRKWs because this lower priority prey stock has less spatial and temporal overlap with the whales, and these individuals are less likely to be encountered as available prey than other Chinook salmon stocks (NMFS and WDFW 2018).

It is unlikely that SRKWs would intercept and feed on the individual 24-25 salmon that may be removed as a result of research, including the up to 2 individual Chinook salmon within the highest use SRKW foraging habitat (Puget Sound and Washington Coast), so we conclude that the effective loss caused by the proposed research activities would have an insignificant effect on the whales' prey base. In addition, as described in Section 2.5 the estimated Chinook salmon mortality is likely to be much smaller than stated. The mortality rate estimates for most of the proposed studies are purposefully inflated to account for potential accidental deaths and it is therefore very likely that fewer salmonids will be killed by the research than stated. In fact, as described in Section 2.7 according to our take tracking over the past five years researchers have only killed about 6% of the naturally-produced juvenile CVSR Chinook salmon they were permitted to kill (and even fewer adults). Thus, the actual effective reduction in prey available to SRKWs is likely to be closer to one adult CVS Chinook salmon, assuming it would be present when the whales are foraging off the coast of California. For PS and LCR Chinook salmon the reported proportions of take have been less than a quarter of what was authorized for natural-origin juveniles (23% and 18%, respectively). Therefore the actual effective reduction in PS or LCR Chinook salmon adults is more likely to be zero than a single adult of either ESU. Such potential reductions in prey would be immeasurably small in the foraging habitat of SRKWs.

Given these circumstances, and the fact that we anticipate no direct interaction between any of the researchers and the SRKWs, NMFS finds that potential adverse effects of the proposed research on SRKWs are insignificant and determines that the proposed action may affect, but is not likely to adversely affect, SRKWs or their critical habitat.

3. MAGNUSON-STEVENS FISHERY CONSERVATION AND MANAGEMENT ACT ESSENTIAL FISH HABITAT CONSULTATION

Section 305(b) of the MSA directs Federal agencies to consult with NMFS on all actions or proposed actions that may adversely affect EFH. The MSA (section 3) defines EFH as "those waters and substrate necessary to fish for spawning, breeding, feeding, or growth to maturity." Adverse effect means any impact that reduces quality or quantity of EFH, and may include direct or indirect physical, chemical, or biological alteration of the waters or substrate and loss of (or injury to) benthic organisms, prey species and their habitat, and other ecosystem components, if such modifications reduce the quality or quantity of EFH. Adverse effects on EFH may result from actions occurring within EFH or outside of it and may include site-specific or EFH-wide impacts, including individual, cumulative, or synergistic consequences of actions (50 CFR 600.810). Section 305(b) also requires NMFS to recommend measures that can be taken by the action agency to conserve EFH.

This analysis is based, in part, on the EFH assessment provided by the NMFS and descriptions of EFH contained in the fishery management plans developed by the Pacific Fishery Management Council (PFMC) and approved by the Secretary of Commerce for Pacific Coast salmon (PFMC 2014).

3.1 Essential Fish Habitat Affected by the Project

In the estuarine and marine areas, salmon EFH extends from the nearshore and tidal submerged environments within state territorial waters out to the full extent of the exclusive economic zone (370.4 km) offshore of Washington, Oregon, and California north of Point Conception. The EFH identified within the action areas are identified in the Pacific coast salmon fishery management plan (PFMC 2014). Freshwater EFH for Pacific salmon includes all those streams, lakes, ponds, wetlands, and other water bodies currently, or historically accessible to salmon in Washington, Oregon, Idaho, and California, except areas upstream of certain impassable man-made barriers (as identified by the PFMC), and longstanding, naturally-impassable barriers (i.e., natural waterfalls in existence for several hundred years).

3.2 Adverse Effects on Essential Fish Habitat

As the Biological Opinion above describes, the proposed research actions are not likely, singly or in combination, to adversely affect the habitat upon which Pacific salmon, groundfish, and coastal pelagic species, depend; the research is therefore not likely to affect EFH. All the actions are of limited duration, minimally intrusive, and are entirely discountable in terms of their effects, short-or long-term, on any habitat parameter important to the fish.

3.3 Essential Fish Habitat Conservation Recommendations

No adverse effects upon EFH are expected; therefore, no EFH conservation recommendations are necessary.

3.4 Supplemental Consultation

The Action Agency must reinitiate EFH consultation with NMFS if the proposed action is substantially revised in a way that may adversely affect EFH, or if new information becomes available that affects the basis for NMFS' EFH Conservation Recommendations [50 CFR 600.920(l)].

4. DATA QUALITY ACT DOCUMENTATION AND PRE-DISSEMINATION REVIEW

The Data Quality Act (DQA) specifies three components contributing to the quality of a document. They are utility, integrity, and objectivity. This section of the opinion addresses these DQA components, documents compliance with the DQA, and certifies that this opinion has undergone pre-dissemination review.

4.1 Utility

Utility principally refers to ensuring that the information contained in this consultation is helpful, serviceable, and beneficial to the intended users. The intended users of this opinion are NMFS, USGS, USFWS, BPA, EPA, Corps, and USFS. Other interested parties could include permit applicants, Tribes and residents of affected areas, and others interested in conservation of the affected ESUs and DPSs. A copy of this opinion was preserved on file at the Portland, Oregon office and is available to any applicants, intended users, or interested parties upon request. The document will be available within two weeks at the NOAA Library Institutional Repository [https://repository.library.noaa.gov/welcome]. The format and naming adheres to conventional standards for style.

This ESA section 7 consultation on the issuance of the ESA section 10(a)(1)(A) research permit concluded that the actions will not jeopardize the continued existence of any species. Therefore, the funding/action agencies may carry out the research actions and NMFS may permit them. Pursuant to the MSA, NMFS determined that no conservation recommendations were needed to conserve EFH.

4.2 Integrity

This consultation was completed on a computer system managed by NMFS in accordance with relevant information technology security policies and standards set out in Appendix III, 'Security of Automated Information Resources,' Office of Management and Budget Circular A-130; the Computer Security Act; and the Government Information Security Reform Act.

4.3 Objectivity

Information Product Category: Natural Resource Plan

Standards: This consultation and supporting documents are clear, concise, complete, and unbiased; and were developed using commonly accepted scientific research methods. They adhere to published standards including the NMFS ESA Consultation Handbook, ESA regulations, 50 CFR 402.01 et seq., and the MSA implementing regulations regarding EFH, 50 CFR 600.

Best Available Information: This consultation and supporting documents use the best available information, as referenced in the References section. The analyses in this opinion and EFH consultation contain more background on information sources and quality.

Referencing: All supporting materials, information, data and analyses are properly referenced, consistent with standard scientific referencing style.

Review Process: This consultation was drafted by NMFS staff with training in ESA, and reviewed in accordance with West Coast Region ESA quality control and assurance processes.

5. REFERENCES

5.1 Federal Register Notices

June 16, 1993 (58 FR 33212). Designated Critical Habitat; Sacramento River Winter-Run Chinook Salmon.

January 4, 1994 (59 FR 440). Endangered and Threatened Species; Status of Sacramento River Winter-run Chinook Salmon; Final Rule

October 31, 1996 (61 FR 56138). Endangered and Threatened Species; Threatened Status for Central California Coast Coho Salmon Evolutionarily Significant Unit (ESU).

March 23, 1999 (64 FR 14067). Endangered and Threatened Species; Regulations Consolidation.

May 5, 1999 (64 FR 24049). Final Rule: Designated Critical Habitat: Critical Habitat for 19 Evolutionarily Significant Units of Salmon and Steelhead in Washington, Oregon, Idaho, and California.

September 16, 1999 (64 FR 50394). Endangered and Threatened Species; Threatened Status for Two Chinook Salmon Evolutionarily Significant Units (ESUs) in California.

June 28, 2005 (70 FR 37160). Endangered and Threatened Species: Final Listing Determinations for 16 ESUs of West Coast Salmon, and Final 4(d) Protective Regulations for Threatened Salmonid ESUs.

September 2, 2005 (70 FR 52488). Final Rule: Endangered and Threatened Species: Designation of Critical Habitat for Seven Evolutionarily Significant Units of Pacific Salmon and Steelhead in California.

September 2, 2005 (70 FR 52630). Final Rule: Endangered and Threatened Species: Designated Critical Habitat: Designation of Critical Habitat for 12 Evolutionarily Significant Units of West Coast Salmon and Steelhead in Washington, Oregon, and Idaho.

November 18, 2005 (70 FR 69903). Final Rule: Endangered and Threatened Wildlife and Plants: Endangered Status for Southern Resident Killer Whales.

January 5, 2006 (71 FR 834). Final Rule: Endangered and Threatened Species: Final Listing Determinations for 10 Distinct Population Segments of West Coast Steelhead.

April 7, 2006 (71 FR 17757). Endangered and Threatened Wildlife and Plants: Threatened Status for Southern Distinct Population Segment of North American Green Sturgeon

November 29, 2006 (71 FR 69054). Final Rule: Endangered and Threatened Species; Designation of Critical Habitat for Southern Resident Killer Whale.

May 11, 2007 (72 FR 26722). Final Rule: Endangered and Threatened Species: Final Listing Determination for Puget Sound Steelhead.

October 9, 2009 (74 FR 52300). Final Rulemaking to Designate Critical Habitat for the Threatened Southern Distinct Population Segment of North American Green Sturgeon.

March 18, 2010 (75 FR 13012). Endangered and Threatened Wildlife and Plants: Threatened Status for Southern Distinct Population Segment of Eulachon.

October 20, 2011 (76 FR 65324). Final Rule: Endangered and Threatened Species; Designation of Critical Habitat for the Southern Distinct Population Segment of Eulachon.

April 2, 2012 (77 FR 19552). Endangered and Threatened Species; Range Extension for Endangered Central California Coast Coho Salmon.

April 14, 2014 (79 FR 20802). Final Rule: Endangered and Threatened Wildlife; Final Rule To Revise the Code of Federal Regulations for Species Under the Jurisdiction of the National Marine Fisheries Service.

February 11, 2016 (81 FR 7214). Final Rule: Interagency Cooperation—Endangered Species Act of 1973, as Amended; Definition of Destruction or Adverse Modification of Critical Habitat.

February 11, 2016 (81 FR 7414). Final Rule: Listing Endangered and Threatened Species and Designating Critical Habitat; Implementing Changes to the Regulations for Designating Critical Habitat.

February 24. 2016 (81 FR 9252). Final Rule: Endangered and Threatened Species; Designation of Critical Habitat for Lower Columbia River Coho Salmon and Puget Sound Steelhead.

February 19, 2019 (84 FR 4791). Endangered and Threatened Species; Take of Anadromous Fish.

March 8, 2019 (84 FR 8507). Endangered and Threatened Species; Take of Anadromous Fish.

5.2 Literature Cited

Abatzoglou, J. T., D. E. Rupp, and P. W. Mote. 2014. Seasonal climate variability and change in the Pacific Northwest of the United States. Journal of Climate. 27(5):2125-2142.

Ainslie, B. J., J. R. Post, and A. J. Paul. 1998. Effects of pulsed and continuous DC electrofishing on juvenile rainbow trout. North American Journal of Fisheries Management: 18(4):905-918.

AMIP (Adaptive Management and Implementation Plan). 2020. The FCRPS Adaptive Management and Implementation Plan (AMIP) ESU-Level Abundance and Trend Tracking Spreadsheet—updated January, 2020. J. Thompson pers comm. Feb. 6, 2020.

Bartholomew, A. and J. Bohnsack. 2005. A Review of Catch-and-Release Angling Mortality with Implications for No-take Reserves. Reviews in Fish Biology and Fisheries. 15:129-154.

Beamer, E. M., R. E. McClure, and B. A. Hayman. 2000. Fiscal Year 1999 Skagit River Chinook Restoration Research. Skagit System Cooperative.

Bendock, T. and M. Alexandersdottir. 1993. Hooking mortality of Chinook salmon released in the Kenai River, Alaska. North American Journal of Fisheries Management. 13:540-549.

Bergman, P. K., K. B. Jefferts, H. F. Fiscus, and R. C. Hager. 1968. A preliminary evaluation of an implanted, coded wire fish tag. Washington Department of Fisheries, Fisheries Research Papers. 3(1):63-84.

Booth, D. B., D. Hartley, and R. Jackson. 2002. Forest cover, impervious-surface area, and the mitigation of stormwater impacts. J Amer Water Res Assoc. 38(3):835-845.

Bordner, C. E., S. I. Doroshov, D. E. Hinton, R. E. Pipkin, R. B. Fridley, and F. Haw. 1990. Evaluation of marking techniques for juvenile and adult white sturgeons reared in captivity *In* Parker, N.C., Giorgi, A.E., Heindinger, R.C., Jester, D.B., Prince, E.D., and Winans, G.A., eds. Fish Marking Techniques, Symposium 7: American Fisheries Society, Bethesda, MD, p. 293-303.

BPA (Bonneville Power Administration). 2018. Comparative Survival Study of PIT-tagged Spring/Summer/Fall Chinook, Summer Steelhead, and Sockeye. 2018 Annual Report (12-1-2017 to 11-30-2018). BPA contract 70765, BPA Project 1996-020-00

Bruesewitz, S. L. 1995. Hook placement in steelhead. Technical Report No. AF95-01. Washington Department of Fish and Wildlife, Olympia.

Brynildson, O. M. and C. L. Brynildson. 1967. The effect of pectoral and ventral fin removal on survival and growth of wild brown trout in a Wisconsin stream. Transactions of the American Fisheries Society 96:353-355.

Buchanan, S. A., A. P. Farrell, J. Fraser, P. Gallaugher, R. Joy and R. Routledge. 2002. Reducing Gill-Net Mortality of Incidentally Caught Coho Salmon. *North American Journal of Fisheries Management* 22:1270–1275, 2002

California HSRG (Hatchery Scientific Review Group). 2012. California hatchery review report Appendix VIII – Feather River Hatchery Spring Chinook Program Report. Prepared for the U.S. Fish and Wildlife Service and Pacific States Marine Fisheries Commission. June 2012. Available at: Feather Spring Chinook Program Report June 2012.pdf

CDFG (California Department of Fish and Game). 1998. A Status Review of the Spring-Run Chinook Salmon [*Oncorhynchus tshawytscha*] in the Sacramento River Drainage. Candidate Species Status Report 98-01. California Department of Fish and Game.

CDFW (California Department of Fish and Wildlife). 2012. Recovery Strategy of California Coho Salmon Progress Report 2004-2012.

CDFW (California Department of Fish and Wildlife). 2018. California Central Valley Chinook Population Database Report - GrandTab 2018.04.09. Available at: GrandTab 2018.04.09

Center for Whale Research. 2018. Chinook Orca Survival – FACTS about Chinook Salmon. Center for Whale Research - Chinook Orca Survival webpage

Chisholm, I. M. and W. A. Hubert. 1985. Expulsion of dummy transmitters by rainbow trout. Transactions of the American Fisheries Society. 114:766-767.

CHSRG (California Hatchery Scientific Review Group). 2012. California Hatchery Review Report – Appendix VIII: Coleman National Fish Hatchery Steelhead Program Report. Prepared for the US Fish and Wildlife Service and Pacific States Marine Fisheries Commission. June 2012. Available at: California Hatchery Review Project Appendix VIII - Coleman NFH steelhead program report

Coble, D. W. 1967. Effects of fin-clipping on mortality and growth of yellow perch with a review of similar investigations. Journal of Wildlife Management 31:173-180.

Conner, W. P., H. L. Burge, and R. Waitt. 2001. Snake River fall Chinook salmon early life history, condition, and growth as affected by dams. Unpublished report prepared by the U.S. Fish and Wildlife Service and University of Idaho, Moscow, ID. 4 p.

Cowen, L. 2007. Effects of angling on chinook salmon for the Nicola River, British Columbia, 1996-2002. North Americana Journal of Fisheries Management 27:256-267.

Cox-Rogers, S., T. Gjernes, and E. Fast. 1999. Canadian Stock Assessment Secretariat Research Document 99/127. Fisheries and Oceans Canada. 16 p.

Crozier, L. G., A. P. Hendry, P. W. Lawson, T. P. Quinn, N. J. Mantua, J. Battin, R. G. Shaw, and R. B. Huey. 2008. Potential responses to climate change in organisms with complex life histories: evolution and plasticity in Pacific salmon. Evolutionary Applications. 1(2):252-270.

Crozier, L. G., M. D. Scheuerell, and E. W. Zabel. 2011. Using Time Series Analysis to Characterize Evolutionary and Plastic Responses to Environmental Change: A Case Study of a Shift Toward Earlier Migration Date in Sockeye Salmon. The American Naturalist. 178(6):755-773.

Cuo, L., D. P. Lettenmaier, M. Alberti, and J. E. Richey. 2009. Effects of a century of land cover and climate change on the hydrology of the Puget Sound basin. Hydrol. Process. 23:907-933.

Dalbey, S. R., T. E. McMahon, and W. Fredenberg. 1996. Effect of electrofishing pulse shape and electrofishing-induced spinal injury to long-term growth and survival of wild rainbow trout. North American Journal of Fisheries Management. 16:560-569.

DFO (Department of Fisheries and Oceans Canada). 2020. 2020 Eulachon Integrated Fisheries Management Plan – Fraser River. Department of Fisheries and Oceans Canada-Pacific Region. 71pp.

Dominguez, F., E. Rivera, D. P. Lettenmaier, and C. L. Castro. 2012. Changes in Winter Precipitation Extremes for the Western United States under a Warmer Climate as Simulated by Regional Climate Models. Geophysical Research Letters. 39(5). DOI:10.1029/2011GL050762.

Doney, S. C., M. Ruckelshaus, J. E. Duffy, J. P. Barry, F. Chan, C. A. English, H. M. Galindo, J. M. Grebmeier, A. B. Hollowed, N. Knowlton, J. Polovina, N. N. Rabalais, W. J. Sydeman, and L. D. Talley. 2012. Climate Change Impacts on Marine Ecosystems. Annual Review of Marine Science. 4:11-37.

Dwyer, W. P. and R. G. White. 1997. Effect of electroshock on juvenile Arctic grayling and Yellowstone cutthroat trout growth 100 days after treatment. North American Journal of Fisheries Management. 17:174-177.

Feely, R. A., T. Klinger, J. A. Newton, and M. Chadsey (editors). 2012. Scientific summary of ocean acidification in Washington state marine waters. NOAA Office of Oceanic and Atmospheric Research Special Report.

Fletcher, D. H., F. Haw, and P. K. Bergman. 1987. Retention of coded-wire tags implanted into cheek musculature of largemouth bass. North American Journal of Fisheries Management 7:436-439.

Ford, M. J. (ed.). 2011. Status review update for Pacific salmon and steelhead listed under the Endangered Species Act: Pacific Northwest. U.S. Depart. of Commer., NOAA Tech. Memo. NOAA-TM-NWFSC-113, 281 pp.

Ford, M. J. 2013. Status review update of Southern Resident killer whales. U.S. Dept. of Commerce, Northwest Fisheries Science Center.41p. Available at (Accessed July 2015): Status review update of Southern Resident killer whales weblink

Fredenberg, W. A. 1992. Evaluation of electrofishing-induced spinal injuries resulting from field electrofishing surveys in Montana. Montana Department of Fish, Wildlife and Parks, Helena.

Glick, P., J. Clough, and B. Nunley. 2007. Sea-Level Rise and Coastal Habitats in the Pacific Northwest: An analysis for Puget Sound, southwestern Washington, and northwestern Oregon. National Wildlife Federation, Seattle, WA.

Goode, J. R., J. M. Buffington, D. Tonina D. J. Isaak, R. F. Thurow, S. Wenger, D. Nagel, C. Luce, D. Tetzlaff, and C. Soulsby. 2013. Potential effects of climate change on streambed scour and risks to salmonid survival in snow-dominated mountain basins. Hydrological Processes 27(5):750-765.

Griffith, J., M. Alexandersdottir, R. Rogers, J. Drotts, and P. Stevenson. 2004. 2003 annual Stillaguamish smolt report. Stillaguamish Tribe of Indians.

Gustafson, R., Y.-W. Lee, E. Ward, K. Somers, V. Tuttle, and J. Jannot. 2016. Status review update of eulachon (*Thaleichthys pacificus*) listed under the Endangered Species Act: southern distinct population segment. 25 March 2016 Report to National Marine Fisheries Service – West Coast Region from Northwest Fisheries Science Center, 2725 Montlake Blvd. E., Seattle, WA 98112.

Hanson, M. B., K. L. Ayres, R. W. Baird, K. C. Balcomb, K. Balcomb-Bartok, J. R. Candy, C. K. Emmons, J. K. B. Ford, M. J. Ford, B. Gisborne, J. Hempelmann-Halos, G. S. Schorr, J. G. Sneva, D. M. Van Doornik, and S. K. Wasser. 2010a. Species and stock identification of prey consumed by endangered southern resident killer whales in their summer range. Endangered Species Research. 11:69–82.

Hanson, B., J. Hempelmann-Halos, and D. Van Doornik. 2010b. Species and stock identification of scale/tissue samples from southern resident killer whale predation events collected off the Washington coast during PODs 2009 cruise on the McArthur II, March 16, 2010. Unpublished memorandum

Hay, D. E., P. B. McCarter, R. Joy, M. Thompson, and K. West. 2002. Fraser River Eulachon Biomass Assessments and Spawning Distribution: 1995-2002. Canadian Science Advisory Secretariat Research Document 2002/117. 58pp.

Healey, M. C., and W. Ra Heard. 1984. Inter- and intra-population variation in the fecundity of chinook salmon (*Oncorhynchus tshawytscha*) and its relevance to life history theory. Can. J. Fish. Aquat. Sci. 4l:474-483.

Healey, M. C. 1991. The life history of Chinook salmon (*Oncorhynchus tshawytscha*). *In* C. Groot and L. Margolis (eds), Life history of Pacific salmon, p. 311-393. Univ. BC Press.

Hollender, B. A. and R. F. Carline. 1994. Injury to wild brook trout by backpack electrofishing. North American Journal of Fisheries Management. 14:643-649.

Hockersmith, E. E., W. D. Muir , S. G. Smith , B. P Sanford , N. S. Adams , J. M. Plumb, R. W. Perry, and D. W. Rondorf. 2000. Comparative performance of sham radiotagged and PIT-tagged juvenile salmon. Report to U.S. Army Corps of Engineers, Contract W66Qkz91521282, 25 p.

Hooton, R. S. 1987. Catch and release as a management strategy for steelhead in British Columbia. *In* R. Barnhart and T. Roelofs, editors. Proceedings of Catch and Release Fishing: a Decade of Experience, a National Sport Fishing Symposium. Humboldt State University, Arcata, California.

Howe, N. R. and P. R. Hoyt. 1982. Mortality of juvenile brown shrimp *Penaeus aztecus* associated with streamer tags. Transactions of the American Fisheries Society. 111:317-325.

Huhn, D. and R. Arlinghaus. 2011. Determinants of hooking mortality in freshwater recreational fisheries: a quantitative meta-analysis. *In* The angler in the environment: social, economic, biological, and ethical dimensions: proceedings of the 5th World Recreational Fishing Conference, number 75 in American Fisheries Society symposium. American Fisheries Society, Bethesda, Md.

IPCC (Intergovernmental Panel on Climate Change). 2014. Climate Change 2014: Synthesis Report. Contribution of Working Groups I, II and III to the Fifth Assessment Report of the Intergovernmental Panel on Climate Change [Core Writing Team, R.K. Pachauri and L.A. Meyer (eds.)]. IPCC, Geneva, Switzerland, 151 pp.

ISAB (Independent Scientific Advisory Board). 2007. Climate change impacts on Columbia River Basin fish and wildlife. ISAB Climate Change Report, ISAB 2007-2, Northwest Power and Conservation Council, Portland, Oregon.

Isaak, D. J., S. Wollrab, D. Horan, and G. Chandler. 2012. Climate change effects on stream and river temperatures across the northwest US from 1980–2009 and implications for salmonid fishes. Climatic Change. 113(2):499-524.

Jenkins, W. E. and T. I. J. Smith. 1990. Use of PIT tags to individually identify striped bass and red drum brood stocks. American Fisheries Society Symposium 7:341-345.

Kamler, J. F. and K. L. Pope. 2001. Nonlethal Methods of Examining Fish Stomach Contents. Reviews in Fisheries Science. 9(1):1-11.

Kier, M.C., J. Hileman, and S. Cannata. 2015. Annual Report Trinity River Basin Salmon and Steelhead Monitoring Project.

Kohlhorst, D. W. 1979. Effect of first pectoral fin ray removal on survival and estimated harvest rate of white sturgeon in the Sacramento-San Joaquin estuary. California Department of Fish and Game. 65: 173-177.

Krahn, M. M., P. R. Wade, S. T. Kalinowski, M. E. Dahlheim, B. L. Taylor, M. B. Hanson, G. M. Ylitalo, R. P. Angliss, J. E. Stein, and R. S. Waples. 2002. Status review of southern resident killer whales (*Orcinus orca*) under the Endangered Species Act. NOAA Technical Memorandum NMFS-NWFSC54, U.S. Department of Commerce, Seattle, Washington.

Krahn, M. M., M. B. Hanson, R. W. Baird, R. H. Boyer, D. G. Burrows, C. E. Emmons, J. K. B. Ford, L. L. Jones, D. P. Noren, P. S. Ross, G. S. Schorr, and T.K. Collier. 2007. Persistent organic pollutants and stable isotopes in biopsy samples (2004/2006) from Southern Resident killer whales. Marine Pollution Bulletin. 54:1903-1911.

Kunkel, K. E., L. E. Stevens, S. E. Stevens, L. Sun, E. Janssen, D. Wuebbles, K. T. Redmond, and J. G. Dobson. 2013. Regional Climate Trends and Scenarios for the U.S. National Climate Assessment: Part 6. *Climate of the Northwest U.S. NOAA Technical Report NESDIS 142-6*. 83 pp. National Oceanic and Atmospheric Administration, National Environmental Satellite, Data, and Information Service, Washington, D.C.

Langness, O. P., L. L. Lloyd, S. M. Schade, B. J. Cady, L. B. Heironimus, P. E. Dionne, and A. M. Claiborne. 2020. Status of Eulachon in Washington: Annual Report July 2018 - July 2019. Fish Program Report Number FPA 20-03, February 27, 2020. Washington Department of Fish and Wildlife. Olympia, WA. 103pp.

Lawson, P. W., E. A. Logerwell, N. J. Mantua, R. C. Francis, and V. N. Agostini. 2004. Environmental factors influencing freshwater survival and smolt production in Pacific Northwest coho salmon (*Oncorhynchus kisutch*). Canadian Journal of Fisheries and Aquatic Sciences. 61(3):360-373

Lewis, M., E. Brown, B. Sounhein, M. Weeber, E. Suring, and H. Truemper. 2009. Status of Oregon stocks of coho salmon, 2004 through 2008. Monitoring Program Report Number OPSW-ODFW-2009-3, Oregon Department of Fish and Wildlife, Salem, Oregon.

Lewis, M., B. Sounhein, M. Weeber, and E. Brown. 2010. Status of Oregon stocks of coho salmon, 2009. Monitoring Program Report Number OPSW-ODFW-2010-3, Oregon Department of Fish and Wildlife, Salem, Oregon.

Lewis, M., M. Weeber, E. Brown, and B. Sounhein. 2011. Status of Oregon stocks of coho salmon, 2010. Monitoring Program Report Number OPSW-ODFW-2011-3, Oregon Department of Fish and Wildlife, Salem, Oregon.

Lewis, M., E. Brown, B. Sounhein, and M. Weeber. 2012. Status of Oregon stocks of coho salmon, 2011. Monitoring Program Report Number OPSW-ODFW-2012-3, Oregon Department of Fish and Wildlife, Salem, Oregon.

Lewis, M., B. Sounhein, M. Weeber and E. Brown. 2014. Status of Oregon stocks of coho salmon, 2012. Monitoring Program Report Number OPSW-ODFW-2013-3, Oregon Department of Fish and Wildlife, Salem, Oregon.

Light, R. W., P. H. Adler, and D. E. Arnold. 1983. Evaluation of Gastric Lavage for Stomach Analyses. North American Journal of Fisheries Management. 3:81-85.

Lindsay, R. B., R. K. Schroeder, and K. R. Kenaston. 2004. Hooking mortality by anatomical location and its use in estimating mortality of spring Chinook salmon caught and released in a river sport fishery. North American Journal of Fisheries Management 24:367-378.

Mantua, N., I. Tohver, and A. Hamlet. 2009. Impacts of Climate Change on Key Aspects of Freshwater Salmon Habitat in Washington State. *in* The Washington Climate Change Impacts Assessment: Evaluating Washington's Future in a Changing Climate, M. M. Elsner, J. Littell, and L. Whitely Binder, Eds. The Climate Impacts Group, University of Washington, Seattle, Washington, pp. 217-253.

Mantua, N., I. Tohver, and A. Hamlet. 2010. Climate change impacts on streamflow extremes and summertime stream temperature and their possible consequences for freshwater salmon habitat in Washington State. Climatic Change. 102(1):187-223.

Matthews, K. R. and R. H. Reavis. 1990. Underwater tagging and visual recapture as a technique for studying movement patterns of rockfish. American Fisheries Society Symposium. 7:168-172.

Mattole Salmon Group. 2011. Spawning Ground Surveys, 2010-2011 Season Mattole River Watershed – Final Report. Petrolia, CA. 41 pp.

McElhany, P., M. H. Ruckelshaus, M. J. Ford, T. C. Wainwright, and E. P. Bjorkstedt. 2000. Viable salmonid populations and the recovery of evolutionarily significant units. U.S. Dept. Commer., NOAA Tech. Memo NMFS-NWFSC-42. 156pp.

McMahon, T. E. and G. F. Hartman. 1989. Influence of cover complexity and current velocity on winter habitat use by juvenile coho salmon (*Oncorhynchus kisutch*). Canadian Journal of Fisheries and Aquatic Sciences. 46:1551-1557.

McMichael, G. A. 1993. Examination of electrofishing injury and short-term mortality in hatchery rainbow trout. North American Journal of Fisheries Management 13:229-233.

McMichael, G. A., L. Fritts, and T. N. Pearsons. 1998. Electrofishing injury to stream salmonids; injury assessment at the sample, reach, and stream scales. North American Journal of Fisheries Management. 18:894-904.

McNeil, F. I. and E. J. Crossman. 1979. Fin clips in the evaluation of stocking programs for muskellunge (*Esox masquinongy*). Transactions of the American Fisheries Society. 108:335-343.

Mears, H. C. and R. W. Hatch. 1976. Overwinter survival of fingerling brook trout with single and multiple fin clips. Transactions of the American Fisheries Society 105: 669-674.

Meehan, W.R. and R.A. Miller. 1978. Stomach flushing: effectiveness and influence on survival and condition of juvenile salmonids. J. Fish. Res. Board Can. 35:1359-1363.

Mellas, E. J. and J. M. Haynes. 1985. Swimming performance and behavior of rainbow trout (*Salmo gairdneri*) and white perch (*Morone americana*): effects of attaching telemetry transmitters. Canadian Journal of Fisheries and Aquatic Sciences 42:488-493.

Metheny, M., and W. Duffy. 2014. Sonar estimation of adult salmonid abundance in Redwood Creek, Humboldt County, California 2012-2013. Report for California Department of Fish and Wildlife Fisheries Restoration Grants Program.

Meyer, J. L., M. J. Sale, P. J. Mulholland, and N. L. Poff. 1999. Impacts of climate change on aquatic ecosystem functioning and health. JAWRA Journal of the American Water Resources Association. 35(6):1373-1386.

Mongillo, P. E. 1984. A summary of salmonid hooking mortality. Washington Department of Game, Olympia.

Mora, E. A., R. D. Battleson, S. T. Lindley, M. J. Thomas, R. Bullmer, L. J. Zarri, and A. P. Klimley. 2018. Estimating the Annual Spawning Run Size and Population Size of the Southern Distinct Population Segment of Green Sturgeon. Transactions of the American Fisheries Society. 147:195-203.

Moring, J. R. 1990. Marking and tagging intertidal fishes: review of techniques. American Fisheries Society Symposium. 7:109-116.

Morrison, J. and D. Zajac. 1987. Histologic effect of coded wire tagging in chum salmon. North American Journal of Fisheries Management 7:439-441.

Mote, P. W., J. Abatzoglou, and K. Kunkel. 2013. Climate Change in the Northwest: Implications for Our Landscapes, Waters, and Communities. Island Press, 224 pp.

Mote, P. W, A. K. Snover, S. Capalbo, S. D. Eigenbrode, P. Glick, J. Littell, R. R. Raymondi, and W. S. Reeder. 2014. Ch. 21: Northwest. *in* Climate Change Impacts in the United States: The

Third National Climate Assessment, J. M. Melillo, T.C. Richmond, and G.W. Yohe, Eds., U.S. Global Change Research Program, pp. 487-513.

Mote, P. W., D. E. Rupp, S. Li, D. J. Sharp, F. Otto, P. F. Uhe, M. Xiao, D. P. Lettenmaier, H. Cullen, and M. R. Allen. 2016. Perspectives on the cause of exceptionally low 2015 snowpack in the western United States. Geophysical Research Letters. 43:10980-10988. doi:10.1002/2016GLO69665

Muoneke, M. and W. M. Childress. 1994. Hooking Mortality: A Review for Recreational Fisheries. Reviews in Fisheries Science. 2:123-156.

Nelson, T., M. Rosenau, and N. T. Johnston. 2005. Behavior and Survival of Wild and Hatchery-Origin Winter Steelhead Spawners Caught and Released in a Recreational Fishery. North American Journal of Fisheries Management. 25(3):931-943.

Nickelson, T.E. 1998. A Habit-Based Assessment of Coho Salmon Production Potential and Spawner Escapement Needs for Oregon Coastal Streams. INFORMATION REPORTS NUMBER 98-4. Oregon Department of Fish and Wildlife. April, 1998.

Nicola, S. J. and A. J. Cordone. 1973. Effects of fin removal on survival and growth of rainbow trout (*Salmo gairdneri*) in a natural environment. Transactions of the American Fisheries Society. 102(4):753-759.

Nielsen, L. A. 1992. Methods of marking fish and shellfish. American Fisheries Society Special Publication 23. Bethesda, Maryland.

NMFS (National Marine Fisheries Service). 2000. Guidelines for electrofishing waters containing salmonids listed under the Endangered Species Act, June 2000. Available at: NOAA Fisheries Guidelines for Electrofishing Waters webpage

NMFS (National Marine Fisheries Service). 2005. Assessment of NOAA Fisheries' critical habitat analytical review teams for 12 evolutionarily significant units of West Coast salmon and steelhead. NMFS, Protected Resources Division, Portland, Oregon.

NMFS (National Marine Fisheries Service). 2006. Final supplement to the Puget Sound Salmon Recovery Plan. Available at: Final supplement to PS Salmon Recovery Plan weblink

NMFS (National Marine Fisheries Service). 2008. Recovery plan for Southern Resident Killer Whales (*Orcinus orca*). National Marine Fisheries Service, Northwest Region, Seattle, Washington.

NMFS (National Marine Fisheries Service). 2009b. Middle Columbia Steelhead ESA Recovery Plan. National Marine Fisheries Service, West Coast Region, Portland, OR. 260 pp.

NMFS (National Marine Fisheries Service). 2012. Final Recovery Plan for Central California Coast coho salmon Evolutionarily Significant Unit. National Marine Fisheries Service, Southwest Region, Santa Rosa, California.

NMFS (National Marine Fisheries Service). 2013. ESA Recovery Plan for Lower Columbia River Coho Salmon, Lower Columbia River Chinook Salmon, Columbia River Chum Salmon, and Lower Columbia River Steelhead. National Marine Fisheries Service, West Coast Region, Portland, OR. 503 pp.

NMFS (National Marine Fisheries Service). 2014a. Recovery Plan for the Evolutionarily Significant Units of Sacramento River Winter-run Chinook Salmon and Central Valley Spring-run Chinook Salmon and the Distinct Population Segment of California Central Valley Steelhead. California Central Valley Area Office. July 2014.

NMFS (National Marine Fisheries Service). 2014b. Final Recovery Plan for the Southern Oregon/Northern California Coast Evolutionarily Significant Unit of Coho Salmon (*Oncorhynchus kisutch*). National Marine Fisheries Service. Arcata, CA. 406 pp.

NMFS (National Marine Fisheries Service). 2015b. Southern Distinct Population Segment of the North American Green Sturgeon (*Acipenser medirostris*) – 5-Year Review: Summary and Evaluation. National Marine Fisheries Service. Long Beach, CA. 42 pp.

NMFS (National Marine Fisheries Service). 2016a. Coastal Multispecies Recovery Plan. National Marine Fisheries Service, West Coast Region, Santa Rosa, California.

NMFS (National Marine Fisheries Service). 2016b. Final ESA Recovery Plan for Oregon Coast Coho Salmon (*Oncorhynchus kisutch*). National Marine Fisheries Service, West Coast Region, Portland, OR. 230 pp.

NMFS (National Marine Fisheries Service). 2017c. Endangered Species Act Recovery Plan for the Southern Distinct Population Segment of Eulachon (*Thaleichthys pacificus*). National Marine Fisheries Service, West Coast Region, Portland, OR. 132 pp.

NMFS (National Marine Fisheries Service). 2018a. Proposed Recovery Plan for the Puget Sound Steelhead Distinct Population Segment (*Oncorhynchus mykiss*). National Marine Fisheries Service. Seattle, WA. 291 pp.

NMFS (National Marine Fisheries Service). 2018b. Recovery Plan for the Southern Distinct Population Segment of North American Green Sturgeon (*Acipenser medirostris*). National Marine Fisheries Service, Sacramento, CA. 95 pp.

NWFSC (Northwest Fisheries Science Center). 2015. Status review update for Pacific salmon and steelhead listed under the Endangered Species Act: Pacific Northwest. December 21, 2015. 357 pp.

ODFW (Oregon Department of Fish and Wildlife). 2011. Upper Willamette River Conservation and Recovery Plan for Chinook Salmon and Steelhead. August, 2011.

ODFW (Oregon Department of Fish and Wildlife) and NMFS (National Marine Fisheries Service). 2011. Upper Willamette River Conservation and Recovery Plan for Chinook Salmon and Steelhead. 462 pp.

ODFW (Oregon Department of Fish and Wildlife) and WDFW (Washington Department of Fish and Wildlife). 2014. 2014 Joint Staff Report: Stock Status and Fisheries for Spring Chinook, Summer Chinook, Sockeye, Steelhead, and Other Species, and Miscellaneous Regulations. Joint Columbia River Management Staff, Oregon Department of Fish & Wildlife, and Washington Department of Fish & Wildlife. January 22, 2014.

ODFW (Oregon Department of Fish and Wildlife) and WDFW (Washington Department of Fish and Wildlife). 2015. 2015 Joint Staff Report: Stock Status and Fisheries for Spring Chinook, Summer Chinook, Sockeye, Steelhead, and Other Species, and Miscellaneous Regulations. Joint Columbia River Management Staff, Oregon Department of Fish & Wildlife, and Washington Department of Fish & Wildlife. January 21, 2015.

ODFW (Oregon Department of Fish and Wildlife) and WDFW (Washington Department of Fish and Wildlife). 2016. 2016 Joint Staff Report: Stock Status and Fisheries for Spring Chinook, Summer Chinook, Sockeye, Steelhead, and Other Species, and Miscellaneous Regulations. Joint Columbia River Management Staff, Oregon Department of Fish & Wildlife, and Washington Department of Fish & Wildlife. January 20, 2016.

ODFW (Oregon Department of Fish and Wildlife) and WDFW (Washington Department of Fish and Wildlife). 2017. 2017 Joint Staff Report: Stock Status and Fisheries for Spring Chinook, Summer Chinook, Sockeye, Steelhead, and Other Species. Joint Columbia River Management Staff, Oregon Department of Fish & Wildlife, and Washington Department of Fish & Wildlife. November 9, 2017.

ODFW (Oregon Department of Fish and Wildlife) and WDFW (Washington Department of Fish and Wildlife). 2018. 2018 Joint Staff Report: Stock Status and Fisheries for Spring Chinook, Summer Chinook, Sockeye, Steelhead, and Other Species. Joint Columbia River Management Staff, Oregon Department of Fish & Wildlife, and Washington Department of Fish & Wildlife. February 20, 2018.

Pauley, G. B., B. M. Bortz, and M. F. Shepard. 1986. Species profiles: life histories and environmental requirements of coastal fishes and invertebrates (Pacific Northwest) -- steelhead trout. U.S. Fish Wildl. Serv. Biol. Rep. 82(11.62). U.S. Army Corps of Engineers, TR EL-82-4. 24 pp.

Peltz, L. and J. Miller. 1990. Performance of half-length coded wire tags in a pink salmon hatchery marking program. American Fisheries Society Symposium 7:244-252.

Pettit, S. W. 1977. Comparative reproductive success of caught-and-released and unplayed hatchery female steelhead trout (*Salmo gairdneri*) from the Clearwater River, Idaho. Transactions of American Fisheries Society. 106(5):431-435.

PFMC (Pacific Fishery Management Council). 2013. Appendix B, Historical Record of Escapement to Inland Fisheries and Spawning Areas. Review of 2012 Ocean Salmon Fisheries (Document prepared for the Council and its advisory entities.) Pacific Fishery Management Council, 7700 NE Ambassador Place, Suite 101, Portland, OR 97220-1384.

PFMC (Pacific Fishery Management Council). 2014. Appendix A to the Pacific Coast Salmon Fishery Management Plan, as modified by Amendment 18. Identification and description of essential fish habitat, adverse impacts, and recommended conservation measures for salmon. 227 pp.

Prentice, E. F. and D. L. Park. 1984. A study to determine the biological feasibility of a new fish tagging system. Annual Report of Research, 1983-1984. Project 83-19, Contract DEA179-83BP11982.

Prentice, E. F., T. A. Flagg, and C. S. McCutcheon. 1987. A study to determine the biological feasibility of a new fish tagging system, 1986-1987. Bonneville Power Administration, Portland, Oregon.

Prentice, E. F., T. A. Flagg, and C. S. McCutcheon. 1990. Feasibility of using implantable passive integrated transponder (PIT) tags in salmonids. American Fisheries Society Symposium 7: 317-322.

Quinn, T. P. 2005. The Behavior and Ecology of Pacific Salmon and Trout. Published by University of Washington Press. 2005. 378 pp.

Raymondi, R. R., J. E. Cuhaciyan, P. Glick, S. M. Capalbo, L. L. Houston, S .L. Shafer, and O. Grah. 2013. Water Resources: Implications of Changes in Temperature and Precipitation *in* Climate Change in the Northwest: Implications for Our Landscapes, Waters, and Communities, M. M. Dalton, P. W. Mote, and A. K. Snover, Eds., Island Press, Washington, DC, pp. 41-58.

Reeder, W. S., P. R. Ruggiero, S. L. Shafer, A. K. Snover, L. L Houston, P. Glick, J. A. Newton, and S. M. Capalbo. 2013. Coasts: Complex Changes Affecting the Northwest's Diverse Shorelines. *in* Climate Change in the Northwest: Implications for Our Landscapes, Waters, and Communities, M. M. Dalton, P. W. Mote, and A. K. Snover, Eds. Island Press, Washington, DC, pp 41-58.

Reingold, M. 1975. Effects of displacing, hooking, and releasing on migrating adult steelhead trout. Transactions of the American Fisheries Society. 104(3):458-460.

Ricker, S.J , D. Ward, and C.W. Anderson. 2014. Results of Freshwater Creek Salmonid Life Cycle Monitoring Station 2010-2013. California Department of Fish and Game, Anadromous Fisheries Resource Assessment and Monitoring Program, 50 Ericson Ct., Arcata, CA 95521.

Rondorf, D. W. and W. H. Miller. 1994. Identification of the spawning, rearing and migratory requirements of fall Chinook salmon in the Columbia River Basin. Prepared for the U.S. Dept. of Energy, Portland, OR. 219 p.

Sandercock, F.K. 1991. Life history of coho salmon (*Oncorhynchus kisutch*). In Pacific salmon life histories. Edited by C. Root and L. Marolis. UBC Press, Vancouver, BC. pp. 296 – 445.

Scheuerell, M. D. and J. G. Williams. 2005. Forecasting climate-induced changes in the survival of Snake River spring/summer Chinook salmon (*Oncorhynchus tshawytscha*). Fisheries Oceanography. 14:448-457.

Schill, D. J., and R. L. Scarpella. 1995. Wild trout regulation studies. Annual performance report. Idaho Department of Fish and Game, Boise.

Schisler, G. J. and E. P. Bergersen. 1996. Post release hooking mortality of rainbow trout caught on scented artificial baits. North American Journal of Fisheries Management. 16(3):570-578.

Scholz, N. L., M. S. Myers, S. G. McCarthy, J. S. Labenia, J. K. McIntyre, G. M. Ylitalo, L. D. Rhodes, C. A. Laetz, C. M. Stehr, B. L. French, B. McMillan, D. Wilson, L. Reed, K. D. Lynch, S. Damm, J. W. Davis, and T. K. Collier. 2011. Recurrent die-offs of adult coho salmon returning to spawn in Puget Sound lowland urban streams. PLos One. 6(12):1-12

Schroeder, R. K., K. R. Kenaston, and R. B. Lindsay. 2000. Spring Chinook salmon in the Willamette and Sandy Rivers. October 1998 through September 1999. Annual progress report, Fish Research Project Oregon. Oregon Department of Fish and Wildlife, Portland.

Seiler, D., G. Volkhardt, P. Topping, and L. Kishimoto. 2002. 2000 Green River juvenile salmonid production evaluation. Washington Department of Fish and Wildlife.

Seiler, D., G. Volkhardt, P. Topping, L. Fleischer, T. Miller, S. Schonning, D. Rawding, M. Groesbeck, R. Woodard, and S. Hawkins. 2004. 2003 juvenile salmonid production evaluation report. Green River, Wenatchee River, and Cedar Creek. Washington Department of Fish and Wildlife.

Seiler, D., G. Volkhardt, and L. Fleischer. 2005. Evaluation of downstream migrant salmon production in 2004 from the Cedar River and Bear Creek. Washington Department of Fish and Wildlife.

Sharber, N. G. and S. W. Carothers. 1988. Influence of electrofishing pulse shape on spinal injuries in adult rainbow trout. North American Journal of Fisheries Management. 8:117-122.

Sharber, N. G., S. W. Carothers, J. P. Sharber, J. C. DeVos, Jr., and D. A. House. 1994. Reducing electrofishing-induced injury of rainbow trout. North American Journal of Fisheries Management. 14:340-346.

Sharpe, C. S., D. A. Thompson, H. L. Blankenship, and C. B. Schreck. 1998. Effects of routine handling and tagging procedures on physiological stress responses in juvenile Chinook salmon. Progressive Fish-Culturist. 60(2):81-87.

Snyder, D. E. 1995. Impacts of electrofishing on fish. Fisheries. 20(1):26-27.

Sounhein, B., E. Brown, M. Lewis and M. Weeber. 2014. Status of Oregon stocks of coho salmon, 2013. Monitoring Program Report Number OPSW-ODFW-2014-3, Oregon Department of Fish and Wildlife, Salem, Oregon.

Sounhein, B., E. Brown, M. Lewis and M. Weeber. 2015. Status of Oregon stocks of coho salmon, 2014. Monitoring Program Report Number OPSW-ODFW-2015-3, Oregon Department of Fish and Wildlife, Salem, Oregon.

Sounhein, B., E. Brown, M. Lewis and M. Weeber. 2016. Status of Oregon stocks of coho salmon, 2015. Monitoring Program Report Number OPSW-ODFW-2016-3, Oregon Department of Fish and Wildlife, Salem, Oregon.

Sounhein, B., E. Brown, M. Lewis and M. Weeber. 2017. Status of Oregon stocks of Coho Salmon, 2016. Monitoring Program Report Number OPSW-ODFW-2017-3, Oregon Department of Fish and Wildlife, Salem, Oregon.

Sounhein, B., E. Brown, M. Lewis and M. Weeber. 2018. Western Oregon adult Coho Salmon, 2017 spawning survey data report. Monitoring Program Report Number OPSW-ODFW-2018-3, Oregon Department of Fish and Wildlife, Salem, Oregon.

SSDC (Shared Strategy Development Committee). 2007. Puget Sound Salmon Recovery Plan. Adopted by the National Marine Fisheries Service January 19, 2007. Available on-line at PS Salmon Recovery Plan weblink

Stolte, L. W. 1973. Differences in survival and growth of marked and unmarked coho salmon. Progressive Fish-Culturist 35: 229-230.

Strange, C. D. and G. J. Kennedy. 1981. Stomach flushing of salmonids: a simple and effective technique for the removal of the stomach contents. Fish. Manage. 12:9-15.

Sunda, W. G., and W. J. Cai. 2012. Eutrophication induced CO2-acidification of subsurface coastal waters: interactive effects of temperature, salinity, and atmospheric p CO2. Environmental Science & Technology. 46(19):10651-10659.

TAC [TAC (U.S. v. Oregon Technical Advisory Committee)]. 2008. Biological assessment of incidental impacts on salmon species listed under the Endangered Species Act in the 2008-2017 non-Indian and treaty Indian fisheries in the Columbia River Basin.

Tague, C. L., J. S. Choate, and G. Grant. 2013. Parameterizing sub-surface drainage with geology to improve modeling streamflow responses to climate in data limited environments. Hydrology and Earth System Sciences. 17(1): 341-354.

Taylor, G. and R. A. Barnhart. 1999. Mortality of angler caught and released steelhead. California Cooperative Fish and Wildlife Research Unit, Arcata.

Taylor, M. J. and K. R. White. 1992. A meta-analysis of hooking mortality of non-anadromous trout. North American Journal of Fisheries Management. 12:760-767.

Thompson, K. G., E. P. Bergersen, R. B. Nehring, and D. C. Bowden. 1997. Long-term effects of electrofishing on growth and body condition of brown and rainbow trout. North American Journal of Fisheries Management. 17:154-159.

Tillmann, P., and D. Siemann. 2011. Climate Change Effects and Adaptation Approaches in Marine and Coastal Ecosystems of the North Pacific Landscape Conservation Cooperative Region. National Wildlife Federation.

USDC (United States Department of Commerce). 2009. Endangered and threatened wildlife and plants: final rulemaking to designate critical habitat for the threatened southern distinct population segment of North American green sturgeon. U.S. Department of Commerce, National Marine Fisheries Service. Federal Register 74(195):52300-52351.

USFWS (United States Fish and Wildlife Service) and NMFS (National Marine Fisheries Service). 1998. Endangered Species Consultation Handbook Procedures for Conducting Consultation and Conference Activities Under Section 7 of the Endangered Species Act. U.S. Fish &Wildlife Service and National Marine Fisheries Service.

UCSRB (Upper Columbia Salmon Recovery Board). 2007. Upper Columbia Spring Chinook Salmon and Steelhead Recovery Plan. 352 pp.

Volkhardt, G., P. Topping, L. Fleischer, T. Miller, S. Schonning, D. Rawding, M. Groesbeck. 2005. 2004 Juvenile salmonid production evaluation report. Green River, Wenatchee River, and Cedar Creek. Washington Department of Fish and Wildlife.

Wainwright, T. C. and L. A. Weitkamp. 2013. Effects of Climate Change on Oregon Coast Coho Salmon: Habitat and Life-Cycle Interactions. Northwest Science. 87:219-242.

Waples, R. S. 1991. Definition of "Species" under the Endangered Species Act: Application to Pacific Salmon. U.S. Department of Commerce, NOAA Technical Memorandum, NMFS, F/NWC-194. 29 pp.

Ward, B. R. and P. A. Slaney. 1993. Egg-to-smolt survival and fry-to-smolt density dependence in Keogh River steelhead trout, p. 209-217. *In* R. J. Gibson and R. E. Cutting [ed.] Production of juvenile Atlantic salmon, *Salmon salar*, in natural waters. Can. Spec. Publ. Fish. Aquat. Sci. 118.

WDFW (Washington Department of Fish and Wildlife). 2020. 2020 WDFW Future Brood Document Final. Available at https://wdfw.wa.gov/fishing/management/hatcheries/future-brood.

Welch, H.E. and K. H. Mills. 1981. Marking fish by scarring soft fin rays. Canadian Journal of Fisheries and Aquatic Sciences 38:1168-1170.

Williams, T.H., B.C. Spence, D.A. Boughton, R.C. Johnson, L.G. Crozier, N.J. Mantua, M.R. O'Farrell, and S.T. Lindley. 2016. Viability assessment for Pacific salmon and steelhead listed under the Endangered Species Act: Southwest. U.S. Department of Commerce, NOAA Technical Memorandum NMFS-SWFSC-564.

Winder, M. and D. E. Schindler. 2004. Climate change uncouples trophic interactions in an aquatic ecosystem. Ecology. 85:2100–2106.

Wydoski, R. S. 1977. Relation of hooking mortality and sublethal hooking stress to quality fishery management. Pages 43-87 in R.A. Barnhart and T.D. Roelofs, editors. Proceedings of a national symposium on catch-and-release fishing as a management tool. Humboldt State University, Arcata, California.

Zabel, R. W., M. D. Scheuerell, M. M. McClure, and J. G. Williams. 2006. The interplay between climate variability and density dependence in the population viability of Chinook salmon. Conservation Biology. 20(1):190-200.

Zabel, R. W. 2014. Memorandum to Donna Weiting: Estimation of Percentages for Listed Pacific Salmon and Steelhead Smolts Arriving at Various Locations in the Columbia River Basin in 2014. Northwest Fisheries Science Center. November 4, 2014.

Zabel, R. W. 2015. Memorandum to Donna Weiting: Estimation of Percentages for Listed Pacific Salmon and Steelhead Smolts Arriving at Various Locations in the Columbia River Basin in 2015. Northwest Fisheries Science Center. October 5, 2015.

Zabel, R. W. 2017a. Memorandum for Christopher E. Yates: Update, Corrected Estimation of Percentages for Listed Pacific Salmon and Steelhead Smolts Arriving at Various Locations in the Columbia River Basin in 2016. Northwest Fisheries Science Center. January 25, 2017.

Zabel, R. W. 2017b. Memorandum for Chris Yates: Estimation of Percentages for Listed Pacific Salmon and Steelhead Smolts Arriving at Various Locations in the Columbia River Basin in 2017. Northwest Fisheries Science Center. November 3, 2017.

Zabel, R. W. 2018. Memorandum for Chris Yates: Estimation of Percentages for Listed Pacific Salmon and Steelhead Smolts Arriving at Various Locations in the Columbia River Basin in 2018. Northwest Fisheries Science Center. December 18, 2018.